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THE BRYOLOGIST

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THE CYTOLOGY OF HAPLOMITRIUM HOOKERI

GEOFFREY K. BERRIE[1]

The Order Calobryales comprises two genera, *Calobryum* and *Haplomitrium*. *Calobryum* has five species; *Haplomitrium* has one (Reimers, 1954). There are records of the chromosomes of two species of *Calobryum* and of *Haplomitrium hookeri*.

Tatuno (1933, 1941) describes the chromosomes of *Calobryum rotundifolium* (Mitt.) Schiffn. The gametophyte chromosome number is 9, and the complement includes a large heteropycnotic X-chromosome in the female, and a smaller heteropycnotic Y-chromosome in the male. In the second paper (1941) he shows that the smallest chromosome of the complement is heteropycnotic, as well as the sex chromosome. This chromosome is classified as an "h-chromosome," or heteropycnotic microchromosome. Tatuno (1941) also describes a hyperhaploid race of the same species. He does not refer to nucleoli.

Lorbeer (1934) gives an account of the chromosomes of *Calobryum blumei* Nees (♀ only) and *Haplomitrium hookeri* (both sexes). He finds no heteropycnotic chromosomes or sex chromosomes. Each of these species has a complement of 9 chromosomes in the gametophyte.

The present work was carried out on plants from pure cultures of female *Haplomitrium hookeri* supplied by the University of Cambridge culture collection. The reference number of the culture is 1868/1, and the origin of the material is given as "Prague, 1939."

Plants were fixed as soon as they were taken from the culture tubes, either directly they arrived by post or after 24 hours in a

[1] Contribution from the Dept. of Botany, University College, Ibadan, Nigeria. Present address: Dept. of Botany, University of Sydney, Sydney, Australia.

light place in the laboratory.[2] There was no evident difference in the incidence of cell division between batches of plants treated differently in this respect. The fixative employed was freshly prepared acetic-alcohol (1:3). After fixation, plants were bulk-stained in leucobasic fuchsin following hydrolysis for six minutes in normal hydrochloric acid at 60°C. Apices were squashed in 45% acetic acid. After ringing with wax, the slides were examined, and those which were found suitable were subsequently counter-stained with fast green and made permanent in Canada balsam. This procedure gave a strong red stain to the chromosomes and a contrasting green stain to nucleoli. Some acetocarmine preparations were also made.

All stages of mitosis were examined. The observations of Lorbeer (1934) were confirmed. There are 9 chromosomes (*Figure* 1). The largest chromosome measures nearly 10 μ in length in acetocarmine preparations. The three smallest chromosomes are all about a quarter of the length of the largest. One of the longest chromosomes has a secondary constriction near the end of one arm.

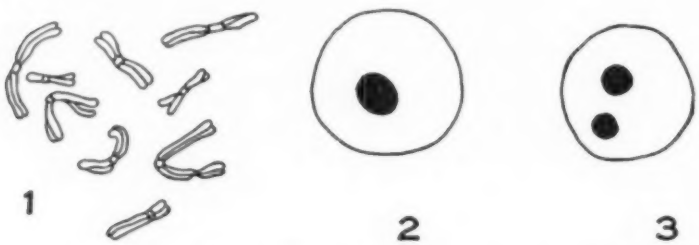

FIG. 1-3. *Haplomitrium hookeri*. 1. Chromosomes at mitosis in a cell from a leaf primordium; leucobasic fuchsin squash preparation. 2-3. Nuclei from cells of a young leaf, showing one nucleolus and two unequal nucleoli, respectively. (All drawings are at a magnification of about 1250.)

Although there is always some heteropycnotic material, the quantity is small and variable and is difficult to assign to specific chromosomes.

Telophase nuclei have two nucleoli each; nuclei at resting stage and prophase generally have one each, but some have two (*Figures* 2 and 3). The two nucleoli formed in a single nucleus are always slightly unequal in size. It is not possible to be certain of the identity of the nucleolar chromosomes. At early prophase all heteropycnotic material is gathered round the nucleolus; at telo-

[2] The plants were received and fixed in the United Kingdom, the day before being flown to Nigeria.

phase the chromosomes are so crowded that the origin of the nucleoli is obscured.

Since only one sex of *H. hookeri* was available, no attempt could be made to identify sex chromosomes; the large chromosome with the secondary constriction is similar to the X-chromosome described and figured by Tatuno (1941) for *Calobryum rotundifolium*.

The description of the chromosomes of *Haplomitrium hookeri* given above is similar to previous records of the cytology of members of the Calobryales, except in the observations on nucleoli.

Tatuno (1941) does not remark on the presence of more than one nucleolus in *Calobryum rotundifolium*.

Heitz (1931) shows that there are two nucleolar chromosomes in the gametophyte complement of *Riccardia pinguis* (L.) Gray, and only one in *Makinoa crispata* Miyake. With the exception of *R. pinguis*, no hepatic has previously been recorded as having two nucleolar organizers in the haploid complement. On the other hand, there are few publications in which nucleoli are referred to, or more than casually figured.

Lorbeer (1934) shows that there is only one nucleolar chromosome in the gametophyte complement of *Frullania dilatata* (L.) Dum. and of *F. ornithocephala* Nees. Wolcott (1939) indicates that there is only one nucleolar chromosome in *Pallavicinia lyellii* (Hook.) Gray. Tatuno (1954) describes the relationships between certain chromosomes and the nucleoli in haploid, diploid, and triploid races of *Dumortiera hirsuta* (Schw.) Reinw. and shows that there is a single nucleolus formed at telophase for every set of 9 chromosomes present. During the course of work on the chromosomes of hepatics I have paid special attention to the nucleoli. My observations are listed in Table 1, together with the records of other workers which I have already quoted.

Although it is possible that other genera will be found to have two nucleoli in gametophyte cells, it seems safe to deduce from these observations that the presence of a second nucleolar organizer in the haploid complement of hepatics is an unusual feature. I have already suggested (Berrie, 1958b) that the presence of two nucleolar organizers in *Riccardia* may be a character of phylogenetic significance. It is interesting to find this same character in a plant belonging to the Calobryales. If it is as rare a character as it seems, its occurrence in members of the Aneuraceae and Calobryales may be of some importance.

The Calobryales and Anacrogynae have two other cytological features in common. One of these is that the Calobryales, Aneuraceae, and certain other members of the Anacrogynae share the

TABLE 1. List of records of the number of nucleoli formed in haploid cells of certain hepatics.

Name of Plant	Nucleoli in haploid cell	Authority
MARCHANTIALES		
Riccia nigerica Jones	1	New record
R. membranacea Steph.	1	New record
Cyathodium africanum Mitt.	1	Berrie, 1958a
Dumortiera hirsuta (Schw.) Reinw.	1	Tatuno, 1954
Marchantia parviloba Steph.	1	Berrie, 1958a
ANACROGYNAE		
Pellia epiphylla (L.) Lindb.	1	New record
Pallavicinia lyellii (Hook.) Gray	1	Wolcott, 1939
Makinoa crispata Miyake	1	Heitz, 1931
Riccardia pinguis (L.) Gray	2	Heitz, 1931; Tatuno & Segawa, 1955
CALOBRYALES		
Haplomitrium hookeri (Smith) Nees	2	New record
ACROGYNAE		
Radula flaccida L. & G.	1	New record
Frullania dilatata (L.) Dum.	1	Lorbeer, 1934
F. ornithocephala Nees	1	Lorbeer, 1934
F. squarrosa (R. Bl. & N.) Nees	1	Berrie, 1958a
F. africana Steph.	1	Berrie, 1958a
Archilejeunea aubrica Vanden Berghen	1	Berrie, 1958a
A. elobulata Steph.	1	New record
Caudalejeunea hanningtonii (Mitt.) Schiffn.	1	Berrie, 1958a
Cololejeunea dissita Jones	1	New record

NOTE: Lorbeer (1934) figures three or four nucleoli per cell at prophase in haploid cells of *Sphaerocarpos donnellii* Aust., but these are probably not nucleoli in the strict sense. In most of his illustrations, and those of other authors, it appears as though there is only one nucleolus associated with the gametophyte set of chromosomes.

distinction of having the largest chromosomes in the Hepaticae. The chromosomes of members of the Marchantiales and Acrogynae are generally rather smaller. The second feature is the large size of the sex chromosomes, compared with the autosomes. *Calobryum*, *Riccardia*, *Pellia*, and *Pallavicinia* all have species with sex chromosome mechanisms in which the X and Y chromosomes are relatively large. Elsewhere, this feature is found only in *Madotheca* and certain species of *Frullania;* there is evidence that it may be derived from a small sex chromosome mechanism in the last two genera.

In these three cytological features the Calobryales are similar to the Anacrogynae rather than to the Acrogynae. Most authors place the Haplomitriaceae (and/or the Calobryaceae) separately as the Order Calobryales (*e.g.*, Reimers, 1954), or in the Acro-

gynae (*e.g.*, Verdoorn, 1932). Horikawa (1934), however, includes them in the Anacrogynae. The cytological evidence seems to justify the view of Horikawa.

Summary

1. *Haplomitrium hookeri* has 9 chromosomes; one of the largest chromosomes has a subterminal constriction in one arm.

2. The gametophyte chromosome set gives two nucleoli at telophase of mitosis.

3. According to available evidence, the possession of two nucleolar organizers in the gametophyte complement is an unusual feature in the Hepaticae.

4. With regard to this feature, and to two other features of the chromosome complement, the Calobryales are cytologically more similar to the Anacrogynae than to the Acrogynae; this is in accordance with the classification of Horikawa (1934).

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ORGANIC NUTRITION OF SOME MOSSES GROWING IN PURE CULTURE

PAUL R. BURKHOLDER[1]

Compared with the extensive floristic studies on mosses, the physiology of this group has been neglected. A few references to the literature of bryophyte morphogenesis and physiology will be mentioned here for orientation. At the beginning of this century, the Marchals (1906) studied sexuality in mosses grown in a chemically defined medium. More recently, Fries (1945) investigated the growth of *Funaria* and *Leptobryum* in nutrient solutions containing glucose and ammonium tartrate. Light was found to be necessary for the initiation of buds and formation of chlorophyll. Servettaz (1913) experimented with growth of *Atrichum undulatum* and other species in pure cultures supplied with peptone and various sugars. Some growth of protonemata was observed even in darkness. Robbins (1918) noted starch formation and growth in protonemata of *Ceratodon purpureus* supplied with soluble carbohydrates in the dark. No leafy shoots grew in darkness, but prolific development of typical moss plants occurred in the light. Differences in growth response of various species of mosses kept in darkness on media containing sugar, peptones, amino acids and yeast autolysate have been reported by the Pringsheims (1935). Species of *Ceratodon* and *Funaria* used glycine, alanine, leucine, asparagine, yeast autolysate and decomposition products of proteins. Chlorophyll in the protonemata diminished with time in darkness. Light was found to be necessary for the development of typical moss plants. Richards (1947) and Berrie (1951) have reported on the general conditions favorable for gross cultivation of mosses.

The experiments of Sirvonal (1947) on *Funaria hygrometrica* led him to postulate four stages in gametophytic development: spore, chloronema, caulonema, and stem bearing the rhizoids and leaves. The important caulonema stage seems to be induced by synthetic processes which occur in the presence of natural light, or, under conditions of artifical light, the caulonema may be stimulated by the activities of contaminating micro-organisms. Sirvonal reported growth-promoting effects of yeast extract and thiamine on the chloronema. Normal differentiation of *Sphagnum* leaves has been investigated in detail by Zepf (1952). Growth and regeneration of mosses have been studied by Bopp (1952), Hughes (1954), Noguchi and Miyata (1957) and Meyer (1948, 1954). Meyer

[1] Brooklyn Botanic Garden, Brooklyn, N. Y.

found that poor growth of certain mosses occurred under conditions of darkness maintained for a period of six months. Following restoration of light, growth of leafy shoots was resumed. It now appears that, though the need for light may vary among different species, for initiation of leafy plants, light is required by many kinds of mosses.

The biochemistry of mosses has received some attention recently, through the quantitative analysis of carbohydrates in *Sphagnum* by Theander (1954), the studies on mineral nutrition by Biebl (1947), and the speculative paper on metabolism of the "copper" mosses by Schatz (1955). Chemical mutation in mosses has been reported by Barkman (1953), and colchicine-induced tumors in *Amblystegium* have been described by Moutschen (1954). Several investigators have shown interest in the effects of substances of the auxin group upon growth and differentiation of moss gametophytes (Kofler, 1951, 1953; Narayanaswami, 1956; Patterson, 1957). Patterson found that growth of the protonema stage in four species of mosses was accelerated by indole acetic acid in the range of 0.01 to 0.5 ppm.

The present investigation is concerned with growth and development of *Atrichum undulatum*, *Sphagnum squarrosum*, and several other mosses maintained in pure cultures in chemically defined media. Results obtained with different carbohydrates, amino acids, purines, and pyrimidines will be presented briefly.

MATERIALS AND METHODS. Spores of *Atrichum* were obtained free from contaminating microbes by washing the capsules in hypochlorite solution, according to the method of Castle and Nickell (1942). The spores were pressed out of the capsules and spread with an inoculating loop over the surface of suitable nutrient agar. After several weeks, leafy shoots developed profusely on agar media. Other species of mosses were obtained in pure culture from the collection of E. G. Pringsheim (1951).

A satisfactory basal medium (Beijerinck, 1898) for these mosses had the following composition in grams per liter: NH_4NO_3, 0.5; KH_2PO_4, 0.2; $MgSO_4 \cdot 7H_2O$, 0.2; $CaCl_2 \cdot 2H_2O$, 0.1, and agar, 9.0. Trace elements were added from a stock solution so as to provide the following in parts per million: B, 0.1; Mn, 0.1; Zn, 0.3; Cu, 0.1; Mo, 0.1; and Fe, 0.5 (Burkholder & Nickell, 1949). The pH was usually adjusted to about 5.5.

Experimental media were dispensed into screw-cap culture tubes, 19 mm. × 150 mm., and sterilized by autoclaving at 15 pounds pressure for 15 minutes. After cooling in a slanted position, the agar media were inoculated with a single moss shoot or a leaf, removed from a stock culture with the aid of a sterile knife

held in a bacteriological loop holder. The knives were made from razor blade fragments, spot-welded to small, steel sewing needles. These knives are very sharp and can be readily sterilized by dipping them in ethanol and flaming. Growth of the moss transplants was allowed to proceed under fluorescent lights in a room kept at a temperature of 72° F. A period of four to six weeks was usually sufficient for completion of each experiment.

EXPERIMENTS. An attempt was made to discover whether leafy shoots of *Atrichum undulatum* would grow in darkness when supplied with different sources of carbon added singly to the basal medium. Twenty-nine compounds were used at a concentration of one percent, in triplicate tubes, each containing a healthy green shoot. After three weeks in darkness, little or no growth was observed. The cultures were then transferred into light and allowed to grow for six weeks. No growth took place in the cultures supplied with fructose, galactose, or arabinose. The order of increasing growth in the other media was as follows: dulcitol, sorbose sorbital, dextrin, inosite, melibiose, ribose, inulin, glycerol, xylose, rhamnose, adonitol, mannitol, lactose, glycogen, starch, raffinose, pectin, cellobiose, glucose, mannose, mellizitose, maltose, levulose, trehalose, sucrose, and no supplement. Presence of different carbohydrates appears not to enhance growth in light above that attained in the basal salts medium. It is concluded that *Atrichum undulatum*, when cultivated in basal medium with added sources of carbon, behaves as an obligate photoautotroph. The possibility exists that in the presence of special nutrients this moss might be able to grow in the absence of light. It is recalled that Fries (1945) observed growth of certain other species in darkness, after buds had been initiated in light.

Under the conditions of our experiments good growth could be obtained in skylight, white fluorescent light, or red neon mixed with white fluorescent light. An intensity of light in the range of about 200 to 400 foot candles of fluorescent light is adequate for growth at a temperature of 65° to 72° F. Survival can be extended over many months at lower intensities of light, at a temperature of about 60° F.

The influence of hydrogen ion concentration on growth was studied in basal Beijerinck's medium adjusted with 0.1 N HCl or NaOH to the following pH values (after autoclaving): 2.6, 4.5, 5.5, 6.0, 6.7, 7.1, and 8.0. Excellent growth occurred at all pH levels between 4.5 and 8.0.

When inorganic sources of nitrogen were supplied either in the form of NH_4Cl, $NaNO_3$, or NH_4NO_3, growth of *Atrichum* was

TABLE 1. Growth responses of *Atrichum undulatum* to different amino acids added singly to basal medium with and without 0.0016 M NH_4NO_3. Relative growth is recorded from 0 to 5, in the three different series, A, B, and C.

Amino Acid	$-NH_4NO_3$ +0.0016 M AA		$+NH_4NO_3$ +0.0016 M AA		$+NH_4NO_3$ +0.0001 M AA	
	Growth	Color	Growth	Color	Growth	Color
Glycine	3	green	5	green	5	brown-green
L-histidine	2	brown-green	4	green	4	brown-green
DL-leucine	1	yellow-green	2	yellow-green	3	yellow-green
DL-isoleucine	1	yellow-green	3	green	4	brown-green
DL-methionine	1	yellow-green	2	green	4	green
DL-phenylalanine	1	yellow-green	4	green	4	brown-green
DL-threonine	1	yellow-green	3	brown-green	5	brown-green
DL-tryptophan	0	brown	0	brown	4	yellow-green
DL-valine	1	yellow-green	3	green	4	brown-green
DL-lysine	1	yellow-green	5	*dark* green	5	brown-green
DL-alanine	2	brown-green	5	brown-green	5	brown-green
DL-aspartic acid	2	brown	4	brown-green	5	brown-green
L-cystine	1	green	3	green	5	green
L-cysteine	2	green	3	green	4	green
DL-glutamic acid	2	dark brown	3	brown-green	5	brown-green
L-arginine	3	yellow-green	5	brown-green	5	brown-green
L-OH proline	1	yellow-green	2	green	4	green
L-proline	3	yellow-green	5	yellow-green	5	brown-green
DL-serine	2	brown	3	green	5	green
L-tyrosine	3	green	5	green	5	brown-green

about equally good at equivalent concentrations of nitrogen. Optimum growth occurred in the basal medium containing NH_4NO_3, at a concentration of 0.002 M. At a level of 0.016 M NH_4NO_3, somewhat less vigorous development of leafy shoots was observed. When nitrogen was omitted from the medium, the green inoculum

turned yellow, and only a small increase in size of the transplant occurred.

The effects of amino acids upon growth of *Atrichum undulatum* were studied in basal medium with NH_4NO_3, to which different amino acids were added singly at two different concentrations, 0.0001 M and 0.0016 M. In another series, the amino acids were added singly, at a level of 0.0016 M, to basal medium from which NH_4NO_3 was omitted. After six weeks, estimates of growth in the three series of media were recorded (TABLE 1).

In the media where amino acids were present, at a concentration of 0.0016 M as the sole sources of nitrogen, good growth was supported by arginine, glycine, tyrosine and proline. Fair growth was made with histidine, alanine, aspartic acid, cysteine, glutamic acid and serine. Tryptophan was distinctly toxic at the 0.0016 M level, both in the presence and absence of NH_4NO_3. Some toxic effects were also noted in media containing higher levels of leucine, hydroxyproline, and methionine. Toxic effects are indicated by reduced growth in cultures of column B, as compared with column C in Table 1. In other experiments, levels of leucine, hydroxyproline and tryptophan as low as 0.001 M inhibited growth of *Atrichum* in media containing adequate amounts of NH_4NO_3. Development of leafy shoots was favored by arginine and glycine. The darkest green color was found in the cultures supplied with NH_4NO_3 plus lysine. Hydroxyproline in the range from 0.0001 M to 0.002 M, in combination with 0.002 M NH_4NO_3, completely inhibited formation of leafy shoots, but allowed growth of protonemata both in and on the surface of the agar medium. Combinations of hydroxyproline, together with glycine and arginine, suppressed formation of leafy shoots and decreased somewhat the growth of protonemata. Peculiarly knotted, branching protonemata were observed in media containing valine and leucine (*Figure* 1), and excessive branching was noted in the presence of serine.

In view of the relatively poor responses made to the transaminating amino acids, aspartic and glutamic, other tests for the affect of these compounds were made over a wider range of concentration. Triplicate cultures were grown in basal medium with glutamic or aspartic acid as the sole source of nitrogen at the following molar levels: none, 0.0001, 0.0005, 0.002, 0.004, and 0.008. After a period of six weeks, only slight increase in leafy shoots and no growth of protonemata occurred in the aspartic acid media. A trace of growth was noted in the glutamic acid series. With small inocula, there was scarcely any difference

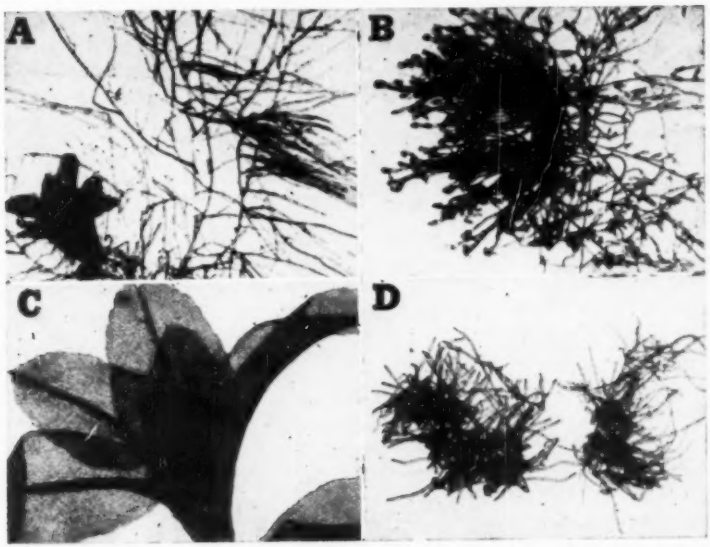

FIG. 1. Appearance of *Atrichum undulatum* when grown in basal medium with supplementary amino acids. A. Slender, branched protonemata with buds are characteristic of the growth on medium containing 0.0064 M phenylalanine. × 10. B. Protonemata show dense clusters on medium containing 0.0032 M leucine as the sole source of nitrogen, × 10. C. Normal leafy shoot grown on basal medium containing arginine as the source of nitrogen, × 10. D. Bunched clusters of protonemata formed in the presence of 0.0032 M hydroxyproline, × 10.

between control cultures without nitrogen, and the tubes containing aspartic or glutamic acids.

Excellent growth of *Atrichum* was obtained in extended tests made with media containing such compounds as arginine, citrulline, ornithine, guanidine chloride, and filtered urea, as the sole sources of nitrogen. The most vigorous development of leafy shoots was found in media containing arginine or ornithine (*Figure* 1).

In preliminary experiments it had been found that excellent growth of *Atrichum* could be obtained in a medium containing yeast nucleic acid. Tests were then made to determine whether purines and pyrimidines might supply nitrogen for growth of *Atrichum* and 14 other cultures of various mosses. The compounds were employed singly in amounts so as to provide nitrogen equivalent to the nitrogen contained in 0.002 M NH_4NO_3. The latter was used in basal medium for comparison. All compounds

were autoclaved in the basal medium. A small portion of vegetative gametophyte was used as inoculum for each agar slant. Growth was observed after six weeks under fluorescent light.

The growth data for *Atrichum* (TABLE 2) indicate that all nitrogen compounds with the exception of uracil and thymine supported growth of leafy shoots. It is possible that NH_2 radicles in cytosine, adenine and guanine may supply nitrogen, but nitrogen would have to come from opened rings of xanthine and uric acid to support growth in media containing these compounds as the sole supply of this element. It is of interest that adenine, guanine and cytosine, which can occur as constituents of both ribo- and desoxy-nucleic acids, support growth, whereas uracil of the ribo-acid and thymine of the desoxy-acid appear to be unavailable as sources of nitrogen for *Atrichum*.

TABLE 2. Growth of leafy shoots and protonemata of *Atrichum undulatum* with single sources of nitrogen supplied by a pyrimidine, a purine, or NH_4NO_3, with the nitrogen equivalent to that in 0.002 M NH_4NO_3. Growth is rated from 0 to 5.

Nitrogen Compound	Leafy Shoots	Protonemata
Adenine	5	1
Guanine	4	1
Xanthine	3	1
Uric acid	3	2
Cytosine	3	1
Uracil	0	0
Thymine	0	1
NH_4NO_3	5	0
No nitrogen	0	1

When growth of many different kinds of mosses was tested in Beijerinck's medium, containing NH_4NO_3, with added uracil or thymine, a wide range of responses was observed. Excellent growth was noted in *Leptobryum pyriforme*, *Splachnum sphaericum*, and many others, but relatively poor development occurred in *Sphagnum squarrosum*. The responses of different species to uric acid and cystosine, supplied as sole nitrogen sources, was variable among the different mosses. Thus, good growth was exhibited on these bases by *Leptobryum pyriforme*, while poor growth was made by *Splachnum sphaericum*.

The very unusual appearance of *Sphagnum squarrosum* on the medium containing NH_4NO_3 plus uracil deserves special mention. This species normally grows very well on Beijerinck's medium containing NH_4NO_3, showing large erect leafy shoots, and a few

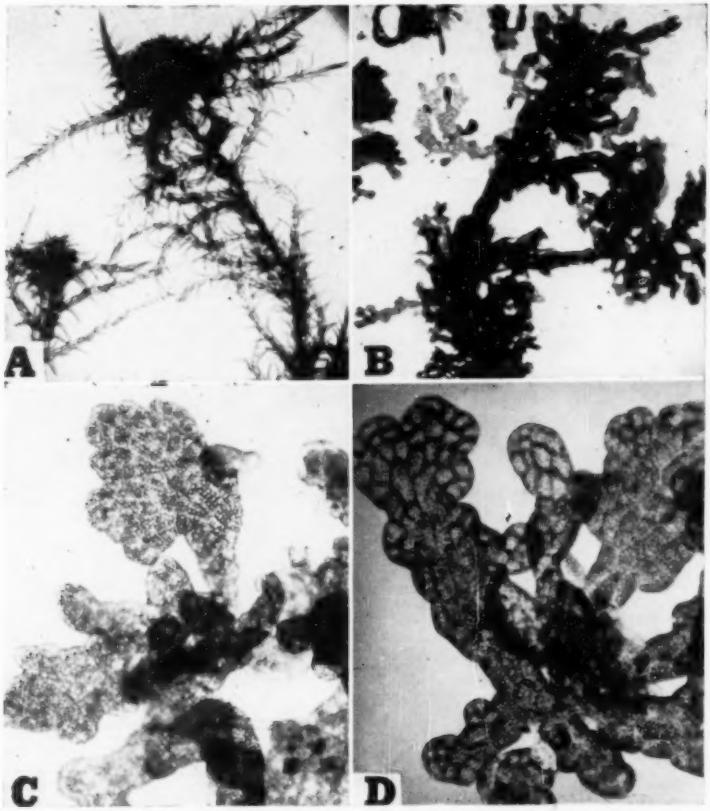

FIG. 2. Effect of uracil upon development of *Sphagnum squarrosum*. A. Normal appearance of leafy shoot growing on basal mineral agar, × 5.7. B. Formation of thalloid outgrowths from old leaves and stem placed upon the surface of agar containing uracil, × 11.4. C-D. Enlarged photomicrographs showing thalloid growth of *Sphagnum* maintained by serial passage for three years in basal nutrient agar containing 224 mg. of uracil per liter, × 68.6.

rhizoids penetrating into the agar (*Figure 2*). In the presence of uracil (224 mg./liter), added to the basal NH_4NO_3 medium, the dark green growth had the form of branching flattened thalli with no vertical axis characteristic of this species. The appearance of these unusual thalloid growths on uracil media is shown in Figure 2. These forms have been carried through series of transplantations in the presence of uracil for three years. When inoculated

into media containing NH_4NO_3, without uracil, there appears to be gradual reversion to the normal leafy shoots characteristic of the species. Thalloid forms of *Sphagnum* have been observed also in media containing aspartic acid, and occasionally atypical development occurs also in the presence of hydroxyproline and glycine.

Other morphogenetic effects brought about in *Atrichum undulatum* by special conditions of nutrition should be mentioned. In basal medium with NH_4NO_3 as the nitrogen source, vigorous development of leafy shoots occurs typically, with formation of only a few protonemata. Excellent development of leay shoots also occurs in this moss grown on arginine. Addition of canavanine (5 mg./liter) to the basal NH_4NO_3 medium resulted in suppression of leafy shoots and extensive development of protonemata. The rôle of certain amino acids, *e.g.*, arginine, in the development of leafy shoots of *Atrichum* may explain the earlier observations of growth and prolific formation of leafy shoots in agar media which contained 100 mg. of casein hydrolysate per liter. Addition of 2% sucrose plus indole acetic acid, 1 part in 10^4 of basal medium, stimulated formation of a heavy mat of protonemata, with no leafy shoots. These observations provide preliminary evidence for the existence of profound effects of organic metabolites on growth and development of mosses.

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NEW OR INTERESTING SPECIES OF PARMELIA IN NORTH AMERICA[1]

MASON E. HALE, JR.[2]

These notes are intended to summarize our current knowledge of a number of new or interesting Parmelias in North America. Two new species, *P. cryptochlorophaea* and *P. haitiensis*, are proposed.

1. PARMELIA AMAZONICA Nyl., Flora 68: 611. 1885. The holotype of *P. amazonica* (Amazon River, *Spruce* 111, Nylander herbarium no. 35111, H) is a scrappy isidiate plant, which, judging from the color tests (thallus K+ yellow, medulla K−, KC+ rose, P+ orange-red), contains atranorine and protocetraric acid. The lobes are 3-5 mm. wide, with a shiny brown underside, rhizinate, but with a narrow bare zone 1-2 mm. wide at the margin. A series of specimens from Florida and tropical America correspond exactly with this plant, thus representing a new record for North America and a range extension of considerable interest. *Parmelia martinicana* Nyl. from the West Indies, a related species, has a more fragile thallus and more or less granular isidia.

Specimens examined. FLORIDA: Sanford, Seminole Co., *S. Rapp*, Sept 2, 1922 (FLAS), 3 mi. S. of Sanford, *Hale* 17608 (US). WEST INDIES: Mt. Morales, near Utuado, Porto Rico, *M. A. Howe* 1162 (NY). CENTRAL AMERICA: Las Casitas, El Paraíso, Honduras, *P. C. Standley, L. Williams,* & *P. Allen* 560 (F). SOUTH AMERICA: Santa Anna da Chapada, Matto Grosso, Brazil, *G. A. Malme* 2408 (S).

2. PARMELIA AUSTROSINENSIS Zahlbr., Symb. Sin. 3: 192. 1930. *P. meridionalis* Tavares, Port. Acta Biol. Ser. B, 1: 159. *Pl.* X, *Fig.* 2. 1945. *P. hyporysalea* sensu Asahina (1952, *pl.* 19, *fig.* 2, p. 129), *nec* Vainio. The nomenclatural history of this plant is quite involved. Zahlbruckner described *P. austrosinensis* from southern China as a typical member of Section Amphigymnia with marginal soredia, no cilia, a pale underside, and a C+ red reaction, certainly an unusual combination of characters. Isosyntypes of this species determined by Zahlbruckner are preserved in the Plitt lichen herbarium (BPI). One collection (*Handel-Mazzetti* 10580), here designated the lectotype, fits the original description perfectly and contains lecanoric acid (C+ blood red).

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The other collection (*Handel-Mazzetti* 8209) is a pseudocyphellate plant, undoubtedly *P. cetrarioides* Del. (C+, olivetoric acid), which in other respects is nearly indistinguishable from *P. austrosinensis*. Perhaps the two species, collected together as a mixture, were not properly sorted for distribution, or Zahlbruckner may have overlooked the tiny pseudocyphellae.

Tavares collected this same plant in Portugal and, without knowledge of Zahlbruckner's species, described it as *P. meridionalis*. Asahina also collected the same plant in Japan and classified it as *P. hyporysalea* Vain. Des Abbayes (1958) recently investigated the type of *P. olivetorum* var. *hyporysalea* Vain. from Africa, which he found to lack soredia and to be conspecific with *P. paraguariensis* Lynge (medulla C+ red, lecanoric acid; Hale, 1958a) from South America. At the same time he recognized the identity of *P. meridionalis* Tav. and the *P. hyporysalea* of Asahina.

Parmelia austrosinensis may now be reported as new for North America in Missouri and Texas on deciduous trees. The species has a very broad pantropical distribution.

Specimens examined. MISSOURI: Near Kirbyville, Taney Co., *Hale* 4400 (US). TEXAS: Near Duffau, Erath Co., *Hale* 5494 (US). SOUTH AMERICA: Assunción, Paraguay, *Handel*, 1890 (G, determined as *P. urceolata* var. *sorediifera* Müll. Arg. by Müller). AFRICA: Addis Abeba, *Prof. Negri*, 1909 (F). CHINA: Gwanyinschen near Guiyang, Setschwan, *Handel-Mazzetti* 10580 (BPI, lectotype of *P. austrosinensis* Zahlbr.). JAPAN: Kawasaki, Totomi, *S. Kurokawa* 51074 (US).

3. PARMELIA CAROLINIANA Nyl., Flora 68: 614. 1885. *P. perlata* var. *subrevoluta* Müll. Arg., Flora 63: 267. 1880. *P. wainioana* Lynge, Ark. Bot. 13: 87. 1914. The distribution of this corticolous lichen in the eastern United States has been summarized by Culberson (1957). Recent collections cited below extend the range of the species into Kentucky and West Virginia. It may be expected throughout the coniferous forests of the southeastern United States. I have also found *P. caroliniana* to be widely distributed in the American tropics, but under other names, as indicated under synonymy. The presently known range now includes southern United States, the West Indies, Central America, and Brazil. All of the specimens contained atranorine and perlatolic acid.

Specimens examined. WEST VIRGINIA: 3 mi. SW. of Jordan Run, Grant Co., *Hale* 14991, 14998 (US); Summersville, Nicolas Co., *Hale* 10087 (US); 4 mi. N. of Sugar Grove, Pendleton Co., *Hale* 15076 (US). KENTUCKY: 4 mi. NE. of Whitley City, McCreary Co., *Hale* 13744 (US); 5 mi. SW. of Corbin, Whitley Co., *Hale* 13474 (US). WEST INDIES: Jamaica, elev. 4000 ft., *C. C. Plitt*, July 19, 1932 (BPI). HONDURAS: Vicinity of El Zamorano, Morazán, *P. C. Standley* 238 (F). NICARAGUA: Vicinity of

Casa Colorado near El Crucero, Managua, *P. C. Standley* 8432 (F). BRAZIL: Petropolis, *Deventer* 45 (G, holotype of *P. perlata* var. *subrevoluta* Müll. Arg.); Santa Anna da Chapada, Matto Grosso, *G. A. Malme* 2435C (S, holotype of *P. wainioana* Lynge).

4. PARMELIA CROZALSIANA B. de Lesd. *ex* Harmand, Lichens de France. 555. 1909. Sbarbaro has distributed a number of duplicates of *P. crozalsiana* from Italy, presumably based on determinations by Bouly de Lesdain. The type of this species is probably lost. The Italian specimens fit the original description, however, quite closely: Lobes 5-10 mm. wide, sorediate on the surface, reticulately rugose, medulla K+ yellow (stictic acid proved), C—, KC—. This species is now known from seven eastern states. It is noteworthy that no older collections have been seen in herbaria, but the records are based on recent field work by me and Culberson. It resembles *P. aurulenta* Tuck., which has more diffuse soredia, a plane thallus, and a yellowish medulla. *Parmelia sbarbaronis*, which differs only in size, is discussed below.

Specimens examined. OHIO: Scioto State Forest, Ross Co., *Hale* 13576 (US). KENTUCKY: 2 mi. E. of Paducah, McCracken Co., *Hale* 13691 (US). INDIANA: Near Deputy, Jefferson Co., *Hale* 14097 (US). ILLINOIS: Dixon Springs, Pope Co., *Hale* 13980 (US). VIRGINIA: 1 mi. N. of Gillespie, Bedford Co., *Hale* 15761 (US); Madison, Madison Co., *Hale* 18455 (US). NORTH CAROLINA: 1 mi. SW. of Tarboro, Edgecombe Co., *W. L. Culberson* 4954 (DUKE); Plymouth, Washington Co., *W. L. Culberson* 6586 (DUKE, US). GEORGIA: Toccoa, Stephens Co., *W. L. Culberson* 7438 (DUKE). ITALY: Arenzano (Genova), Liguria, *C. Sbarbaro*, Jan. 10, 1953 (DUKE, US); Margherita, Liguria, *C. Sbarbaro*, April 1, 1951 (US).

5. **Parmelia cryptochlorophaea,** sp. nov. Thallus dilute olivaceo-glaucescens, usque ad 10 cm. latus, adpressus, subtus castaneus, rhizinis fere usque ad apicem lobarum instructus; laciniae lobatae et incisae, rugulosae, eciliatae, sorediis globosis elevatis margine instructae; medulla alba; apothecia 1-3 mm. lata, adnata; sporae 8, 4-5 × 6-9 μ. Planta atranorinum et acidum cryptochlorophaeicum et materia alba ignota continens.

Thallus green-olivaceous in older specimens, pale greenish mineral gray in fresh material, adnate, 5-10 cm. broad; lobes 3-5 mm. wide, 1-2 cm. long, irregularly lobed and incised, the upper surface more or less rugose, rarely reticulately white-maculate toward the tips as in *P. caroliniana* Nyl.; soredia borne along the margins in globose elevated soralia; lower surface brown, rhizinate with a narrow bare area near the margin; cilia, isidia, pseudocyphellae absent; apothecia 1-3 mm. in diameter, imperforate, rare; spores 8, ovoid, 4-5 × 6-9 μ. Thallus K+ yellow; medulla

K−, C−, KC+ red, atranorine, cryptochlorophaeic acid, and an unidentified fatty substance present.

Type in the U. S. National Herbarium, collected in the Dominican Republic, vicinity of Ciudad Trujillo, Santo Domingo, Sept. 15, 1947, *H. A. Allard* 15715a (*fig.* 1).

Paratypes. GEORGIA: 10 mi. NE. of Midway, Bryan Co., *Hale* 16797 (US). FLORIDA: Highlands Hammock State Park, Highlands Co., *Hale* 16920; 6 mi. SW. of Tallahassee, Leon Co., *Hale* 16989; 5 mi. NE. of Greenville, Madison Co., *Hale* 17609; Sanford, Seminole Co., *S. Rapp* (FH, FLAS), March 7, 1909 (*c. fr.*) (FH). WEST INDIES: Claremont, St. Ann, Jamaica, *H. A. Imshaug* 15890 (MSC); Trinidad, *Lassen* (C, determined as *P. borreroides* Nyl. by Vainio). HONDURAS: Vicinity of Comayagua, Comayagua, *P. C. Standley* 5462, 5930 (F). BRAZIL: Near Guaramiranga, Ceará, *H. C. Cutler* 8072C (F).

This corticolous species bears little resemblance to any other Parmelias except *P. caroliniana* Nyl., which is isidiate, and *P. leucochlora* Tuck., which has neither soredia or isidia. It is distinguished by cryptochlorophaeic acid (confirmed by Asahina, *in lit.*), heretofore known only in *Cladonia*, by the maculate lobes, and by

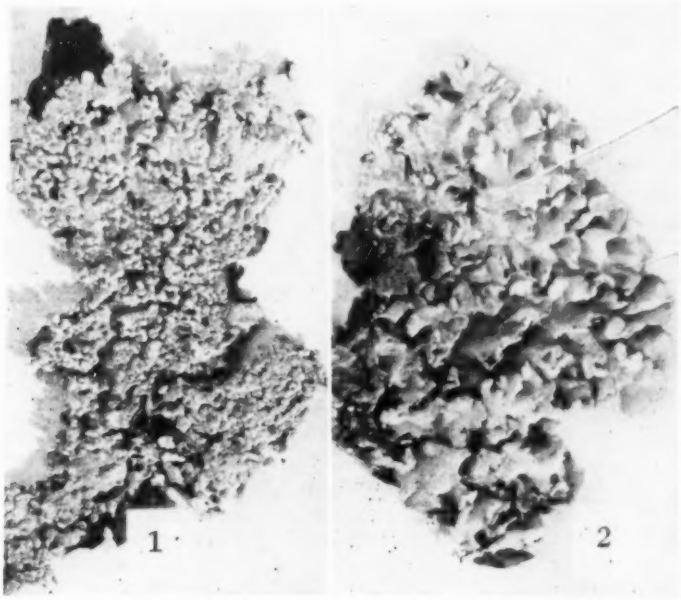

FIG. 1. Holotype of *Parmelia cryptochlorophaea* (*Allard* 15715a), × 1. FIG. 2. Holotype of *Parmelia haitiensis* (*Orcutt* 2087), × 1. (Photographs by the Smithsonian Institution.)

the peculiar soredia. It is evidently widely distributed in the Caribbean region.

6. **Parmelia haitiensis,** sp. nov. Habitu et materia chimica ut in Parmelia recipienda Nyl., sed differt isidiis crebre instructis.

Thallus mineral gray to olivaceous, adnate, 5-10 cm. in diameter; lobes broad and rotund (as in *P. subcrinita* Nyl.), 5-15 mm wide, 10-25 mm. long, sparsely ciliate along the margins, cilia 0.5-2 mm. long; upper surface shiny, white-maculate, densely covered with isidia; lower surface brown, rhizinate almost to the margin and with papillae near the margin; medulla white; apothecia rare, 2-5 mm. in diameter, imperforate, cupuliform; spores 8, ovoid, 6-7 × 9-11 μ. Thallus K+ yellow; medulla K−, C−, P−, KC+ red, atranorine, an unknown substance (KC+ red), and a fatty acid present.

Type in the U. S. National Herbarium, collected in the Blue Mountains, Jamaica, Sept. 7, 1927, *C. R. Orcutt* 2987 (*fig.* 2).

Paratypes. North Carolina: Piney Mountain, Duke Forest, Orange Co., *Culberson* 6496 (DUKE, US). South Carolina: 5 mi. E. of Eutawville, Orangeburg Co., *Culberson* 7715 (DUKE). Florida: no locality, *W. W. Calkins* in 1899 (FLAS). West Indies: Headquarters at M. Deriex, Kenscoff, *W. S. Thomas* 109 (NY, US), and Mission, Fonds Varettes, Haiti, *E. C. Leonard* 3709 (US), 3709b (FH, US); over rock on south slope of Catherines Peak, Blue Mountains, *H. A. Imshaug* 13919 (MSC).

The species at first resembles the common *P. subcrinita,* but on closer inspection the shiny mottled upper surface and the light brown, rhizinate lower surface exclude that species. The residue from ether extraction recrystallizes in G.A.W. as long curved needles and thin rhombic plates. A very close relative is obviously *P. recipienda* Nyl. (Brazil, no. 35212 in Nylander's herbarium at Helsinki), which contains the same chemicals but lacks isidia. The species occurs on both rocks and tree bark.

7. Parmelia lindmanii Lynge, Ark. Bot. 13: 74. 1914. The isidiate *Parmelia perlata* group has at least two representatives with a yellow medulla: *P. sulphurata* Nees & Flot. (syn. *P. persulphurata* Nyl.), which contains vulpinic acid, and *P. lindmanii* Lynge, known only from Brazil, which contains a pale yellow-orange pigment. Among specimens from the southern United States and tropical America labeled indiscriminately as *P. sulphurata* or even *P. tinctorum* Despr., there are many unrecognized records of *P. lindmanii,* which may now be considered the commonest isidiate *Parmelia* with a yellow medulla.

Specimens examined. Florida: Oleno State Park, Alachua Co., *Hale* 16437 (US); Highlands Hammock State Park, Highlands, Co., *Hale* 17021 (US); Sanford, Seminole Co., *S. Rapp.* July 1932 (FLAS). Louisiana:

Near Alexandria, Rapides Co., *R. E. Logan* 882 (WIS). WEST INDIES: Stewart Town, Jamaica, *H. A. Imshaug* 16007 (MSC); near Good Hope Water Works, St. George, Grenada, *H. A. Imshaug* 16230 (MSC). EL SALVADOR: Near Ataco, Ahuachapán, *P. C. Standley* & *E. Padilla V.* 2695 (F). HONDURAS: Near Tela, Atlantida, *P. C. Standley* 54383 (F). BRITISH HONDURAS: Maya Mounds, Cockscomb Forest, *W. A. Schipp* 8103 (F). NICARAGUA: Region of Las Nubes, Masaya, *P. C. Standley* & *H. A. Gamier* 8037 (F). PANAMA: Barro Colorado Island, Canal Zone, *O. Shattuck* 449 (F). SOUTH AMERICA: Lavalleja-Minas-Parque, Uruguay, *H. S. Osorio* 3822 (US); Porto Alegre, Rio Grande do Sul, Brazil, *G. A. Malme* 450 (S, holotype of *P. lindmanii* Lynge).

8. PARMELIA OBSESSA Ach., Synops. 213. 1814. *P. finkii* Zahlbr. *in* Hedrick, Mycol. 26: 162. 1934 *Parmelia obsessa* is an early Acharian species first described from North America from the collections of Muhlenberg. Riddle (1917) studied the holotype at Helsinki and with some doubt considered it an aberrant form of *Parmeliopsis aleurites* (Ach.) Lett. All workers have since followed his interpretation (*cf.* Gyelnik, 1938) and the epithet *obsessa* has not appeared in recent literature. However, an isotype of *P. obsessa* (coll. Muhlenberg, Ach. 45, Sw. 107, PH; these label data are the same as those on the holotype, *fide* I. Hiitonen) has a pale yellow medulla and a black underside (noted by Riddle) and contains atranorine, zeorine, and an unknown yellowish substance in the medulla. None of these characters fit the genus *Parmeliopsis*, but they do fit *Parmelia*. In fact, the isotype shows that *P. obsessa* is identical with the species later described by Zahlbruckner as *P. finkii*, which name it must now replace. A summary of the distribution of the species was published by the writer (1958).

9. PARMELIA OMPHALODES (L.) Ach. This well-known saxicolous species is common in the arctic and subarctic regions of North America. The southern limit in the eastern United States is given as the White Mountains of New Hampshire in Fink's *Lichen flora of the United States*. It may now be reported far south of New England in the Appalachian Mountains of West Virginia, Virginia, and North Carolina, where it grows abundantly on exposed talus slopes at elevations of 1200 m. or more in the spruce-fir zone. The plants all contain atranorine and salacinic acid.

Specimens examined. WEST VIRGINIA: Dolly Sods, Randolph Co., *Hale* 14957 (US); Panther Knob, Pendleton Co., *Hale* 14293. VIRGINIA: Hawksbill Mountain, Page Co., *Hale* 18851; Crescent Rocks, Page Co., *Hale* 18169. NORTH CAROLINA: Roan Mountain, Avery Co., *Hale* 18047.

10. PARMELIA ROBUSTA Degel., K. Vet. Vitterh. Samh. Handl. Ser. B, 1: 33. 1941 (*ubi syn.*). This new name was proposed by

Degelius for members of the *P. perlata* group that have marginal soredia, lack cilia, and react K— in the medula. He noted the close resemblance to *P. cristifera* Tayl., which reacts K+ red (salacinic acid). Both species occur on trees in tropical and subtropical regions and in the United States as far north as southern Georgia. The specimens reacting K— actually contain protocetraric acid, a depsidone closely related to salacinic acid, since both acids react P+ orange-red. There is a slight morphological difference between the two species which Degelius did not mention but which becomes noticeable after the examination of many specimens. *Parmelia robusta* tends to have more dissected sorediate margins, giving a lacerate appearance to the lobes (*cf. pl.* 10, *fig.* 1, in Tavares, 1945), whereas *P. cristifera* has relatively entire sorediate margins. However, a chemical test is the only reliable method of separating the species.

Specimens examined. SOUTH CAROLINA: Santee State Park, Orangeburg Co., *Hale* 16485 (US). GEORGIA: 5 mi. S. of Quitman, Brooks Co., *Hale* 16765 (US). FLORIDA: Oleno State Park, Alachua Co., *Hale* 16431 (US); 8 mi. E. of Ocala, Marion Co., *Hale* 17022 (US); Tomoka State Forest, Volusia Co., *Hale* 17054 (US).

11. PARMELIA SANCTAE-CRUCIS Vain., Ann. Acad. Sci. Fenn. 6: 14. 1915. *P. neglecta* Asahina, Jour. Jap. Bot. 17: 71. 1941. *P. subcetrarioides* des Abb., Bull. Inst. Fr. Afr. Noire 13: 974. 1951. This species has been unrecognized since its description from the West Indies in 1915. It is now known to be widely distributed in the southern United States, the West Indies, Central America, Africa, and Japan. The plant is described and illustrated by Asahina (1952, p. 140) as *P. neglecta*. The only outstanding feature is the unexpected color test, medulla K—, KC—, P—, containing an unknown fatty substance and atranorine. One might easily mistake it for a juvenile specimen of *P. cristifera* or *P. robusta*, but the chemical test will separate it from these. *Parmelia sanctae-crucis* is very common in Florida, even on citrus trees in groves.

Specimens examined. GEORGIA: 3 mi. SW. of Hinesville, Liberty Co., *Hale* 16753 (US). FLORIDA: Highlands Hammock State Park, Highlands Co., *Hale* 16928 (US); Crewsville, Hardee Co., *Hale* 16882 (US). ALABAMA: Gulf Beach, Baldwin Co., *Hale* 7251 (US). LOUISIANA: Plaquemines Co., *A. B. Langlois* 37 (US); Grand Encore Bluff, Red River, Natchitoches Co., *M. N. Andrews* 34 (WIS). WEST INDIES: Hopewell, St. Ann, Jamaica, *H. A. Imshaug* 15814 (MSC); Barbados, *H. A. Imshaug* 16344 (MSC); Fair Plain, St. Croix, *F. Børgesen*, 4/2, 1906 (C, holotype of *P. sanctae-crucis* Vain.). HONDURAS: Vicinity of Siguatepeque, Comayaguay, *P. C. Standley* & *J. Chacón P.* 6392 (F). NICARAGUA: Vicinity of Jinotega, Jinotega, *P. C. Standley* 9675 (F). AFRICA: Kaukan, Guinea

Gallica, Feb. 10, 1948, *H. des Abbayes* (US, isotype of *P. subcetrarioides* des Abb.). JAPAN: Yakushima, Kiusiu, *F. Fujikawa*, July 28, 1933 (US, paratype of *P. neglecta* Asah.).

12. PARMELIA SBARBARONIS B. de Lesd., Bull. Soc. Bot. France 70: 278. 1923. An isotype of this species (FLAS) matches the original description perfectly: Lobes 2-4 mm. wide, reticulately rugose, globose soredia on the upper surface, medulla K+ yellow (stictic acid proved), C—, KC—. This plant is identical with *P. crozalsiana* B. de Lesd. (see above) except for the smaller lobes. It is strange that Bouly de Lesdain did not refer to *P. crozalsiana* when describing *P. sbarbaronis*, since both have the unusual reticulately rugose lobes and stictic acid. *Parmelia sbarbaronis* can now be reported from the West Indies and Central America.

Apparently all the specimens labeled *P. sbarbaronis* by Sbarbaro from Italy (*cf.* Hale, 1959), excepting the isotype, are incorrectly identified. These specimens have rugose lobes but marginal soredia and lecanoric acid (K—, C+ blood red). This species, *P. perreticulata* (Räs.) Hale, is known from Texas and Italy.

Apothecial characters taken from the first known fertile specimen (*Standley* 11655) may be added to the original description as follows: Apothecia numerous, 3-4 mm. in diameter, imperforate, the disk pruinose in younger specimens; hymenium 40-50 μ high, paraphyses strongly coherent, spores 8, 6-6.5 × 9-10 μ; pycnidia numerous along the margins and tips of lobes, conidia straight, 12-14 × 0.8-1. μ

Specimens examined. WEST INDIES: Jamaica, July 15, 1926, C. C. Plitt (BPI). COSTA RICA: Vicinity of San Sebastián, *P. C. Standley*, 49356 (US). HONDURAS: El Zamorano, Morazán, *P. C. Standley* 11655 (F). ITALY: Varazze, Cigliegio a Cantalupo, 1922, *C. Sbarbaro* (FLAS, isotype of *P. sbarbaronis* B. de Lesd.).

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BARK BRYOPHYTE UNIONS IN SOUTHERN IRELAND[1]

EDWIN ALLEN PHILLIPS[2]

In the spring of 1955 some 15 different woods from Dublin to Cork to Killarney (*map* 1) were investigated for bark bryophyte communities, here designated "unions." The work was inspired by Richard's (1938) account of the bryophyte communities of a Killarney oakwood.

Decimeter square quadrats were cut or scraped from the bark at 4.5 ft. above the ground, usually from the north side of the tree

MAP 1. Location of woods in southern Ireland where bark bryophyte unions were studied.

[1] This work was partly supported by grants from the Claremont Graduate School. I am indebted to Stanley Green (University of Birmingham), who acted as field guide and checked identifications, and also to Prof. P. W. Richards (University College of North Wales).

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where optimum bryophyte development occurred. Tentative identifications of species were made in the field, and notes were taken of the stand location, general habitat conditions, tree species, diameter at breast height (D.B.H.), exposure direction and general vertical distribution. In each wood an attempt was made to collect bryophyte communities (as opposed to individual species) from trees of different sizes and ages. Bryophyte specimens have been preserved in the Pomona College Herbarium and the personal collection of Stanley Green.

In the laboratory each of the 96 quadrats was more closely examined, species determinations verified and the cover of each species estimated with the use of a ruled plastic square placed over the quadrat under a binocular dissecting microscope. The square was divided into ten equal sections and the cover of each species was estimated to the nearest ten percent.

A large chart was then constructed with the bryophyte species in a column at the left and the 96 quadrats across the top. In the body of the table was placed the cover of those species occurring in each quadrat.

Since 81 quadrats had a single bryophyte with high cover, a series of raw tables was then drawn up, by placing in the same table those quadrats with the same high cover species. This resulted in four tables of the following species: *Isothecium myosuroides* (24 quadrats), *Neckera complanata* (19 quadrats), *Frullania dilatata* (13 quadrats) and *Hypnum cupressiforme* var. *filiforme* (11 quadrats). In 14 other quadrats various species had a high cover, but no one species occurred in high cover in sufficient quadrats to be given further consideration at this time. These species were *Isothecium myurum* (4 quadrats), *Camptothecium sericeum* and *Neckera pumila* (2 quadrats each), *Metzgeria furcata, Zygodon viridissimus, Plagiochila asplenioides, Hylocomium brevirostre, Thamnium alopecurum* and *Hymenophyllum wilsoni* (1 quadrat each). The remaining 15 quadrats with more than one species of similar high cover included nine quadrats of *Isothecium myosuroides* combined with *Neckera complanata, Frullania dilatata, Hypnum cupressiforme* var. *filiforme* (3 quadrats), *Isothecium myurum* and *Zygodon viridissimus*, one quadrat of *Isothecium myosuroides* with *Neckera pumila, Ulota phyllantha* and *U. bruchii*, and one quadrat of *Isothecium myosuroides* with *Frullania dilatata, Metzgeria furcata, Hypnum cupressiforme* var. *filiforme* and *Neckera pumila* of equal high cover. Six other quadrats contained *Frullania dilatata* in combinations of other species with equal high cover, as follows: two with *Hypnum*

cupressiforme var. *filiforme*, one with *Metzgeria furcata* and *Hypnum cupressiforme* var. *filiforme*, one with *Metzgeria furcata* alone, one with *Neckera pumila* and one with *Plagiochila asplenioides*. Each of these quadrats contained other associated species.

Further consideration was limited to quadrats of the four species found with high cover in more than 10 samples. The quadrats dominated by these bryophytes were organized into unions named for the species of highest cover. Another indication of the rôle of a species in a community is its dispersion. Those species ranging widely throughout the community are more characteristic of the whole community than locally occurring species. This concept is embodied in the term "presence," or when equal-sized samples are used, as in this investigation, "constancy." In each of the four union tables, the constancy of each species was calculated in percentages by dividing the number of localities in which each species occurred in a particular union by the total number of localities in which the union occurred and multiplying by 100. For example, the species for which a union is named would have a constancy of 100 percent, since only quadrats with this species would be in a given union table, whereas if the next species considered occurred in 7 out of 10 localities, it would have a constancy of 70%.

In order to prepare a summary table, an average cover value was determined for each species in each of the four union tables. This was done by totaling the percentages of cover for that species in each of the quadrats of a given union and dividing this by the number of quadrats in which it occurred.

At this point it was evident that most of the common species were present in all possible combinations but were not of equal cover and constancy in these.

According to the concept of "fidelity," communities can be characterized by species restricted to them. Species ranging through several communities are obviously of less value as indicators of a particular community than other species which occur in only one community. Since it is not always possible to discover species strictly limited to a single community, the concept has been broadened to include consideration of species that attain optimum development in a particular community as faithful to that community.

In this investigation, I have used the values for cover and constancy as an indication of fidelity of particular species to particular unions. Those species with high fidelity to a given union on the basis of higher cover and constancy in that union than in the others, are designated as "characteristic species" (see table 1).

TABLE 1. Summary of the unions and their characteristic species based on constancy and average cover.

ISOTHECIUM MYOSUROIDES UNION		
Characteristic Species	Constancy	Average Cover
Isothecium myosuroides	V	5
Neckera pumila	III	1
Lejeunea cavifolia	II	1
Plagiochila asplenioides	+	+
Characteristic of *Isothecium* and *Neckera* unions		
Metzgeria furcata	V	1
Isothecium myurum	II	1
Radula complanata	II	1
Characteristic of *Isothecium* and *Frullania* unions		
Ulota bruchii	I	2
Characteristic of *Neckera* union		
Zygodon viridissimus	III	1
Cryphaea heteromalla	I	1
Neckera complanata	+	+
Orthotrichum striatum	+	+
Tortula laevipila	+	+
Characteristic of *Frullania* union		
Frullania dilatata	V	2
Microlejeunea ulicina	III	1
Ulota phyllantha	+	+
Characteristic of *Hypnum* union		
Hypnum cupressiforme var. *filiforme*	IV	1

NECKERA COMPLANATA UNION		
Characteristic Species	Constancy	Average Cover
Neckera complanata	V	5
Zygodon viridissimus	IV	1
Camptothecium sericeum	III	1
Cryphaea heteromalla	II	1
Orthotrichum striatum	II	1
Tortula laevipila	I	1
Anomodon viticulosus	+	+
Characteristic of *Isothecium* and *Neckera* unions		
Metzgeria furcata	V	1
Isothecium myurum	II	1
Radula complanata	II	1
Characteristic of *Neckera* and *Hypnum* unions		
Orthotrichum lyellii	+	+
Characteristic of *Isothecium* union		
Isothecium myosuroides	V	2
Neckera pumila	II	1
Characteristic of *Frullania* union		
Frullania dilatata	IV	1
Microlejeunea ulicina	II	1
Ulota phyllantha	II	1
Characteristic of *Hypnum* union		
Hypnum cupressiforme var. *filiforme*	II	1

FRULLANIA DILATATA UNION		
Frullania dilatata	V	5
Microlejeunea ulicina	V	1
Ulota phyllantha	III	2
Dicranum scoparium		
Characteristic of *Frullania* and *Isothecium* unions		
Ulota bruchii	I	2
Characteristic of *Isothecium* and *Neckera* unions		
Metzgeria furcata	IV	1
Characteristic of *Isothecium* union		
Isothecium myosuroides	IV	2
Characteristic of *Neckera* union		
Zygodon viridissimus		
Characteristic of *Hypnum* union		
Hypnum cupressiforme var. *filiforme*	IV	2

HYPNUM CUPRESSIFORME VAR. FILIFORME UNION		
Hypnum cupressiforme var. *filiforme*	V	5
Characteristic of *Hypnum* and *Neckera* unions		
Orthotrichum lyellii		
Characteristic of *Isothecium* and *Neckera* unions		
Metzgeria furcata	II	1
Characteristic of *Isothecium* and *Frullania* unions		
Ulota bruchii		
Characteristic of *Isothecium* union		
Isothecium myosuroides	IV	1
Characteristic of *Neckera* union		
Zygodon viridissimus	II	1
Characteristic of *Frullania* union		
Frullania dilatata	IV	2
Microlejeunea ulicina	IV	1

In Table 1 the species are listed in order, with the characteristic species of the union first. Percentage figures for average cover and constancy have been changed to conventional scale values as follows:

Average Cover	Constancy
+ = In 1 quadrat only	+ = In 1 quadrat only
1 = 0-5%	I = 0-20%
2 = 5-25%	II = 20-40%
3 = 25-50%	III = 40-60%
4 = 50-75%	IV = 60-80%
5 = 75-100%	V = 80-100%

Any value of this organization of data lies in the better possibility for interpreting and expressing the relationships of the species. For example, in southern Ireland, the *Neckera complanata* union is the best delineated one with seven characteristic species, *i.e.*, species with the highest average cover and constancy in this union in comparison with the other three unions. That the unions of *Neckera complanata* and *Isothecium myosuroides* are closely related is obvious by the occurrence of three species with equal cover and constancy in each union, of five species characteristic of the *Neckera complanata* union found in the *Isothecium myosuroides* union and of two species characteristic of the *Neckera complanata* union found in the *Isothecium myosuroides* union.

Also in Table 1 these two unions can be contrasted with the *Hypnum cupressiforme* var. *filiforme* union in which that species is the only characteristic one. This species occurs with a constancy of II to IV in the other unions indicating its general subordinate rôle on tree bark in southern Ireland, although in two collected quadrats it was the only bryophyte.

A study of the data for the *Frullania dilatata* union reveals the relatively high constancy of *Isothecium myosuroides* and *Hypnum* in this union. This lends weight to the impression gained in the field of a general successional series (expressed by many other workers) of *Frullania* to *Hypnum* to *Isothecium* to *Neckera* on younger to older trees and on the same tree, with the passage of time.

Table 2 summarizes data for four bryophyte unions and their occurrence on various tree species of different sizes in the various locations. Some trees, *e.g.*, *Arbutus unedo* and *Betula pubescens*, occurred at relatively few of the locations. *Quercus petraea* and *Fagus silvatica* were more widespread. The *Frullania dilatata* union occurred on the smaller trees under 9 in. D.B.H. except on the drier, more acid *Pinus sylvestris* barks, which in this investigation were found to have bryophytes only on trees over 12 in. D.B.H. The *Neckera complanata* union did not occur on *Pinus* or on *Larix decidua* since this union seems to require more moist and less acid conditions. The *Hypnum cupressiforme* var. *filiforme* union also occurred on the smaller trees, though of some-

TABLE 2. Trees, unions, locations and tree diameters. Key to Diameters: S = small, less than 10" D.B.H.; M = medium, 10-19" D.B.H.; L = large, more than 19" D.B.H.

	Isothecium Myosuroides Union		Neckera Complanata Union		Frullania Dilatata Union		Hypnum Cupressiforme var. Filiforme Union		Number of Quadrats
	Location	Diameter	Location	Diameter	Location	Diameter	Location	Diameter	
Arbutus unedo					Ross Island	S			2
Betula pubescens					Ross Island	S			1
Fagus silvatica	Clonroche Blackwater River Tore Falls Glengariff Abbeyleix	L L L L L	Barrow River Caher	S L	Tore Falls Abbeyleix	S L	Ross Island	L	20
Fraxinus excelsior	Clonroche	L	Inishcarra	M					3
Ilex aquifolium					Glengariff	S	Derrycunihy Glengariff	S S	5
Larix decidua	Tore Falls	L			Tore Falls	L	Clonroche	M	4
Pinus sylvestris	Tore Falls	L			Kenmare	L	Blackwater River Kenmare	M L	6

	Isothecium Myosuroides Union		Neckera Complanata Union		Frullania Dilatata Union		Hypnum Cupressiforme var. Filiforme Union		Number of Quadrats
	Location	Diameter	Location	Diameter	Location	Diameter	Location	Diameter	
Quercus petraea	Glen of the Downs Avoca River Blackwater River Inishcarra Derrycunihy Ross Island Galway's Bridge Kenmare Glengariff Abbeyleix	M-L L M M L M M M M L	Glen of the Downs Avoca River Barrow River Inishcarra Ross Island Caher	M-L L M-L S-M M-L M	Derrycunihy Ross Island	L S	Glen of the Downs Avoca River	M M	41
Salix cinerea					Abbeyleix	S			1
Sorbus aucuparia	Blackwater River	S			Ross Island Tore Falls Kenmare	S S S			5
Acer platinoides	Kenmare	M	Caher	M-L					4
Taxus baccata			Blackwater River	L	Ross Island	S	Ross Island	M	4
Number of Tree Species in each union		7		5		9		6	

what larger size than those bearing the *Frullania dilatata* union. The *Isothecium myosuroides* union was most widely distributed and most common although indications are that the *Neckera complanata* union is the final "closed" community on older barks of better moisture conditions in southern Ireland.

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LESKEA ANGUSTATA IN MEXICO

HAROLD ROBINSON[1]

Among some Mexican mosses collected by Teófilo Herrera and Oscar Sanchez in 1956, I encountered one which differed from any previously reported from the area. Following a suggestion by Dr. Howard Crum the specimen was identified as *Leskea angustata* Tayl., previously known only from northern South America. In addition to being the first collection of the species from North America, it is also apparently the first record of the genus for Mexico.

In view of a probably wider distribution in North America, an attempt has been made to supplement the meager information available on the species. A description and illustrations of it have been included, previous illustrations being, apparently, lacking. In addition, information concerning synonymy has been reviewed with the hope of removing some remaining confusion.

Leskea angustata was described by Taylor in 1846 with the following diagnosis and comments:

> L. angustata; caule laxe caespitoso, procumbente, vage ramoso; surculis teretibus; foliis imbricatis, erectis, cordatis, acuminatis, margine basi recurvis, integerrimis, nervo ante apicem evanescente: capsula cylindracea, erectiuscula.—On trunks of tree, about Quito, common. Prof. William Jameson, 1827. (Dr. Greville's Herbarium.)
>
> Stems about 1 inch long, pale olive-green; shoots taper with closely adpressed leaves. Perichaetia lanceolate, erect, a little longer than the capsules. Leaves minutely dotted. Inner peristome of sixteen very short laciniae which are irregular in breadth, united at their bases. Differs from L. rostrata, Hedw. by the more taper[ed] shoots, the more closely adpressed leaves, whose margins are plane above and remarkable by the cylindrical capsules.

[1] Dept. of Botany, Duke University, Durham, N. C.; contribution from the Duke University Dept. of Botany and the University of Tennessee Botanical Laboratory, N. Ser. 187.

With this species Steere (1948) united *Leskea gracillima* (Tayl.) Mitt., based on *Neckera gracillima*, which Taylor described in 1848. Taylor's diagnosis and comments were as follows:

N. gracillima, Tayl. Monoica. Caule adscendente, implexo, vage subpinnatim ramoso; foliis erecto-patentibus, nervo ante apicem evanescente, integerrimis, basi marginibus reflexis; capsula erecta, inaequali, cylindrica, ore contracto.

On tree, on Pichincha. Prof. W. Jameson. Dec., 1846.

Stems scarcely one inch long; shoots very slender, slightly incurved at the tops, green, but often tipped with straw-colour, perhaps from exposure to cold. Perichaetia whitish, shining, occurring towards the base of the shoots. Outer peristome of sixteen trabeculate pale teeth, each marked at the base with a longitudinal opaque line, inner of sixteen pale setaceous laciniae, united at the base by the inner membrane of the capsule. The habit is of Pterogonium filiforme, Hedw., but the peristome is different; besides, the leaves are strongly nerved, and with longer apiculi.

Taylor also described, in 1847, the completely distinct *Leskea angustifolia*.

Since 1848 confusion has arisen from three sources of which one was Mitten's misuse (1869) of the name *Leskea angustata* Tayl. in place of *L. angustifolia* Tayl., considering it as a possible synonym of his *Porotrichum insularum*. (Dr. Crum, in a letter, indicated that *P. insularum* is the same as the true *Leskea angustifolia*.) Mitten's error was followed by Paris (1904-06) and was not corrected until 1948, by Steere.

Another source of confusion concerned the name *Anomodon angustatus* (Tayl.) Hampe (1862). Mitten failed to realize that it was a validly published combination based on *Leskea angustata* Tayl. It was cited by Mitten as a manuscript name under *Leskea gracillima*. Again Mitten's error was followed, and Jaeger (1878), who had unnecessarily made the combination, was cited as its author by Paris. Again Steere (1948) corrected the error.

The final confusion arose from a misinterpretation of Mitten's work by subsequent writers. Both Paris (1904-06) and Brotherus (1925) cited Mitten as author of *Leskea gracillima* as if he had originally described it, and Steere unfortunately based his discussion of the nomenclature of the species on this error. Mitten, however, cited Taylor (1848) as the author. The name *Leskea gracillima* thus was only a new combination by Mitten based on *Neckera gracillima* Tayl.

Steere, while reducing *L. gracillima* to synonymy with *L. angustata*, apparently did not realize that both names were derived from Taylor. A possibility of Taylor's species having been misinterpreted still exists; however, on the basis of specimens seen, Steere's concept has been followed here.

The Mexican specimen was compared with the type of *Leskea gracillima* and with numerous specimens originally named *L. gracillima* and several of *L. angustata*, all from the New York Botanical Garden. The type of *Leskea angustata* was not seen. The Mexican plants differ from the South American material only in having a relatively broader leaf with a less attenuate apex. The South American specimens are among themselves rather variable in this respect, and the Mexican form might be considered only an extreme expression of these variations.

The description and figures have been taken, except where noted, from the Mexican material.

LESKEA ANGUSTATA Tayl., Lond. Jour. Bot. 5: 62. 1846. *Neckera gracillima* Tayl., Lond. Jour. Bot. 7: 192. 1848. *Hypnum columbicum* C. M., Bot. Zeit. 14: 458. 1856. *Anomodon angustatus* (Tayl.) Hampe, Flora 45: 455. 1862. *Lescurea gracillima* (Tayl.) Spruce, Cat. Musc. Amaz. And. p. 21. 1867. *Leskea gracillima* (Tayl.) Mitt., Jour. Linn. Soc. London., Bot. 12: 567. 1869. *Schwetschkea gracillima* (Tayl.) Jaeg., Ber. St. Gall. naturw. Gesell. 1876-77:222. 1878 (not *S. gracillima* Fleisch. 1915). *Anomodon gracillimus* (Tayl.) Jaeg., *op. cit.* 234. Stems procumbent, with numerous clusters of rhizoids near the apex, irregularly branched; leaves 0.6-0.8 mm. long, appressed and rather secund when young and dry, erect when moist, older leaves loosely appressed; leaves broadly ovate with acuminate tips; margin serrulate, somewhat recurved at base; costa convex at back, somewhat roughened, adaxially with two (rarely three) rows of elongated cells exposed toward the base, and ending near the apex; lamina with median cells rhomboidal to oblong, 4-5 μ wide by 7-8 μ long, toward the alar region mostly quadrate, rarely wider than long, rather thick-walled, slightly papillose with thickened cell ends; Autoicous; perichaetial leaves ovate-lanceolate, costa ending nearer middle of leaf; seta reddish, 7-8 mm. long; capsule cylindric, slightly inclined, light brown, about 2 mm. long; operculum conical; annulus none; peristome double; teeth papillose throughout; segments linear, well developed, about as long as the teeth, papillose; spores 18-21 μ, dark-green, very finely roughened.

On trees, 3200 meters alt., El Desierto, Zarco, Distrito Federal, México, *T. Herrera* & *O. Sanchez*, July 16, 1956 (specimens in the herbaria of the National Museum of Canada and the University of Tennessee).

Distribution: Colombia, Ecuador, Peru, Venezuela, Mexico.

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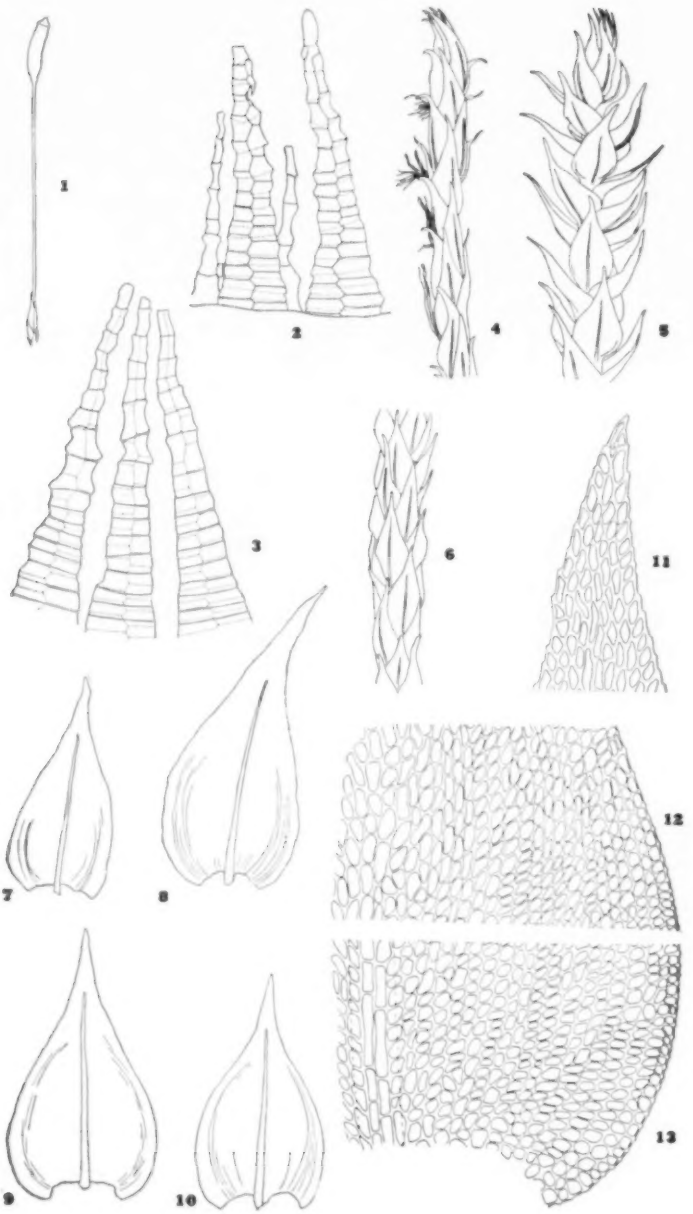
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FIG. 1-13. *Leskea angustata* Tayl. 1. Sporophyte with perichaetium, × 5. 2. Peristome from outer side, with broken inner peristome, × 100. 3. Outer peristome from inner side, × 100. 4. Branch tip, dry, × 23. 5. Branch tip, moist, × 23. 6. Older branch segment, × 23. 7-8. Leaves from type of *L. gracillima*, × 70. 9-10. Leaves from Mexican specimen, × 70. 11. Leaf apex, × 280. 12. Median portion of leaf, midrib not shown, × 280. 13. Basal portion of leaf with midrib, × 280. (Fig. 1-6 and 9-13 from Mexican specimen, 7-8 from Ecudorian type of *L. gracillima*.)

TERRESTRIAL CRYPTOGAMS IN A PINE WOODLAND WITH AND WITHOUT LITTER

THOMAS N. JOHNSEN, JR.[1, 2]

In the North Carolina Piedmont a terrestrial bryophyte community of *Dicranum-Plagiothecium-Leucobryum* is associated with 60-year old pine stands (Bliss & Linn, 1955). The present paper

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[2] The author acknowledges aid given by Dr. Lewis E. Anderson, who confirmed the moss identifications; Dr. H. L. Blomquist, who confirmed the hepatic identifications; Dr. W. L. Culberson, who suggested the problem and identified the lichens; and Dr. C. F. Korstian, who gave permission to use the area.

reports the effects of frequent litter removal, either by burning or by raking, on this community.

In 1934, three 0.2-acre plots were established to study the effects of litter removal upon tree growth, soils, and soil fauna in a pure stand of loblolly pine (*Pinus taeda* L.) in the Durham Division, Compartment 63, Stand 1 of Duke Forest (Durham Co., North Carolina). In 1936 one plot was burned, one raked with wooden-tooth hay rakes, and the remaining one left undisturbed. The treatments were repeated in 1937 and every two years thereafter.

The soils on the plots, of the Alamance series, are shallow with a silty clay or silty clay-loam subsoil. Rock fragments are numerous throughout the soil profile. An erosion pavement is most apparent on the raked area, but erosion has not been sufficient to affect the volume weight of the soils (Malac, 1952).

The prevailing climate of the region is mild, and the average growing season is 200 days. Lowest temperatures occur during January, with a mean temperature of about 39° F. Temperatures rarely go below zero. The highest temperatures are in July, with a mean of about 78°. The average annual precipitation of 41 inches is fairly well distributed throughout the year. (U. S. Dept. of Commerce, 1956.)

At the time of study, the spring of 1956, the pine stand was 55-67 years old. There were few hardwoods and almost no herbaceous vegetation on any of the plots. Figure 1 shows the general aspect and soil surface of the plots, which had been treated the previous spring.

Methods and Materials

Quantitative data were obtained by taking 20 2 × 5 dm. quadrat samples at random in each of the three plots. For each quadrat a chart was prepared from which the cover of mosses, *Anthoceros*, and lichens was determined with a planimeter. Data are in terms of frequency and cover. Frequency expresses the percentage of the quadrats in which any given species or plant group is present and indicates how widespread it is in the plot. Cover expresses the percentage of the area of all the quadrats sampled in a plot covered by the plant group in question and indicates the relative vigor of plant groups in the plot.

All terrestrial bryophytes and lichens in the quadrats were collected for identification in the laboratory. The lichens were identified by morphology and chemistry, thus enabling a determination of even sterile squamules of *Cladonia*. The nomenclature of the mosses follows Grout (1940), that of the Hepaticae

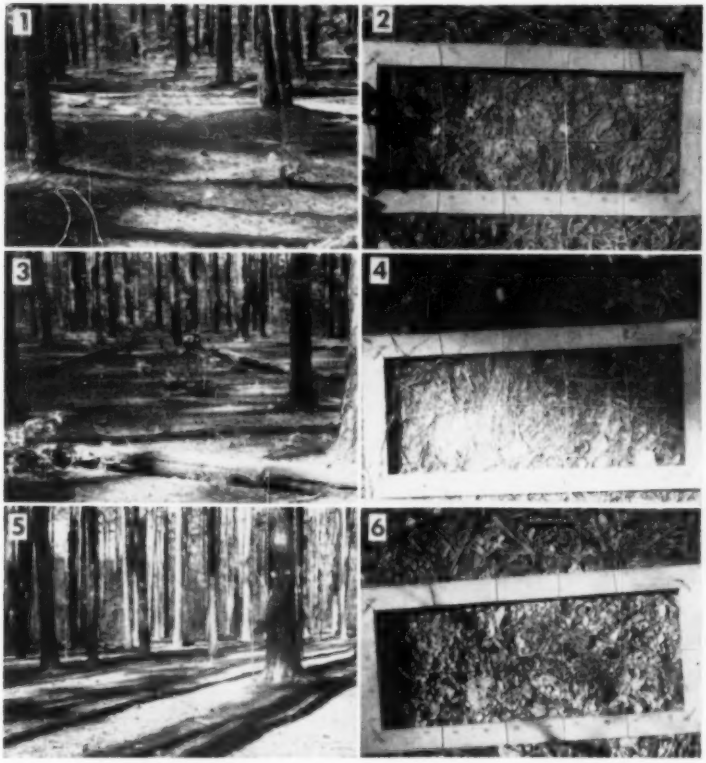

FIG. 1-6. General aspect and soil surface views of the study plots. 1, 2. Undisturbed; 3, 4. Burned. 5, 6. Raked. Note the small amount of undergrowth. The previous years' accumulation of litter had been removed from the quadrats.

Evans (1940), and that of the lichens Hale and Culberson (1956). The collections are deposited in Duke Herbarium.

RESULTS

Table 1 gives the number of species, frequency, and cover of the bryophytes and lichens in each plot.

The undisturbed plot had six species (four mosses and two lichens). It had a total cover of 1.0%, of which 0.7% was lichens. This plot had a total frequency of 20% with a 20% frequency of mosses and a 10% frequency of lichens.

The burned plot had the fewest species: four (two mosses, one *Anthoceros*, and one lichen). The plot had a total cover of 2.1%,

TABLE 1. Number of species, frequency, and cover of bryophytes and lichens in raked, burned, and undisturbed plots.

Plot description	Plant group	Number of species	Frequency (%)	Cover (%)
Undisturbed	Mosses	4	20	0.3
	Lichens	2	10	0.7
	Total	6	20*	1.0
Burned	Mosses	2	15	1.1
	Anthoceros	1	10	0.9
	Lichens	1	5	0.1
	Total	4	20	2.1
Raked	Mosses	7	100	12.7
	Liverworts	2	25	....**
	Lichens	7	85	6.4
	Total	16	100	19.1

* Total frequency is the percentage of quadrats with cryptogams.
** Cover of liverworts was not measured.

mainly of mosses and *Anthoceros*. It had a total frequency of 20%, with 15% frequency of mosses and 10% frequency of *Anthoceros*. This is the only plot on which *Anthoceros* occurred.

The raked plot had the largest number of species: 16 (seven mosses, two liverworts, and seven lichens). This plot had the highest total cover, 19.1%, of which mosses made up 12.7%. It also had the highest total frequency, 100%, with 100% frequency of mosses and 85% frequency of lichens.

Table 2 lists the frequency of the species for each plot. All species found except *Cladonia bacillaris* and *Anthoceros* sp. occurred on the raked plot.

Dicranum condensatum was present on all the plots but was most common in the raked area. *Ditrichum pallidum* occurred on both the raked and the burned areas. *Dicranum scoparium, Leucobryum glaucum, and Plagiothecium micans* occurred on both the raked and the undisturbed plots. *Atrichum angustatum* and *Dicranella heteromalla* occurred only on the raked plot.

Lophocolea heterophylla and *Scapania nemorosa*, the only liverworts found, were on only the raked plots. *Anthoceros* sp. (immature specimens) was limited to the burned plot.

All but one of the species of lichens found in the entire study were present on the raked plot. *Cladonia bacillaris* was limited to the undisturbed area. *C. grayi*, a chemical segregate of *C. chlorophaea*, was found on both the raked and the burned plot.

TABLE 2. Frequency of terrestrial cryptogams occurring in undisturbed, burned, and raked plots.

Species	Frequency (%) on Indicated Plot		
	Undisturbed	Burned	Raked
BRYOPHYTES:			
Anthoceros sp		10	
Atrichum angustatum (Brid.) BSG			80
Dicranella hetromalla (Hedw.) Schimp.			5
Dicranum condensatum Hedw.	5	5	35
D. scoparium Hedw	10		65
Ditrichum pallidum (Hedw.) Hampe		15	25
Leucobryum glaucum (Hedw.) Schimp.	5		70
Lophocolea heterophylla (Schrad.) Dum.			20
Plagiothecium micans (Sw.) Par.	20		80
Scapania nemorosa (L.) Dum.			10
LICHENS:			
Cladonia bacillaris (Ach.) Nyl.	5		
C. cenotea (Flk.) Sandst.			15
C. grayi Merr.			60
C. piedmontensis Merr.			5
C. polycarpia Merr.			5
C. stepsilis (Ach.) Vain.			5
C. subcariosa Nyl.		5	75
Lecidea sp.			5

C. grayi and *C. subcariosa* were the more common lichens in the raked plot. *C. piedmontensis*, *C. polycarpia*, *C. stepsilis*, and *Lecidea* sp. were infrequent and limited to the raked area.

DISCUSSION AND CONCLUSIONS

Terrestrial bryophytes are of low abundance in the pine stands of the North Carolina Piedmont (Bliss & Linn, 1955), perhaps because of excessive shading or covering of the soil by a thick layer of litter. If so, litter removal and the consequently increased light on the exposed soil surface should benefit terrestrial cryptogams. Litter removal would also accelerate erosion, increase soil-water evaporation, and cause more extreme temperature variations (Lutz & Chandler, 1946), all of which would be detrimental to terrestrial cryptogams. If the soil is stony, sheet erosion may produce an erosion pavement which would reduce the rate of erosion and the amount of water evaporation from the soil.

Litter can be removed by burning or raking. Burning destroys most of the litter and releases mineral nutrients to the soil surface for a short time (Lutz & Chandler, 1946); these would benefit soil-dwelling cryptogams. However, fire destroys a large part of the terrestrial cryptogam community. Frequent fires in the New

Jersey Pine Barrens increased the moss and lichen cover (Buell & Cantlon, 1955), but the effect of the fires upon composition of these communities is unknown. There was a greater occupancy by mosses on burned than on check plots noted in Missouri hardwood forests (Paulsell, 1957). In the present study the bryophyte and lichen cover of the burned area was slightly increased over that of the undisturbed plot, but since there were no replications of these plots this difference may be due partly to sampling error. It seems that the composition of the terrestrial cryptogam community is changed by periodic fires since the undisturbed plot was characterized by a *Plagiothecium-Dicranum-Leucobryum-Cladonia* community, whereas the burned plot was characterized by a *Dicranum-Anthoceros* community.

Raking, unlike fire, does not destroy the cryptogam community. By its actions the larger mats of lichens and mosses are broken up and scattered throughout the plot. Raking also disturbs the soil and thereby exposes fresh substrate for the plants. The raked plot had a heterogeneous community with a large number of species well distributed through the plot, a characteristic of communities in frequently disturbed areas.

It appears that periodic litter removal from pine woodlands of the North Carolina Piedmont markedly affects the terrestrial bryophyte and lichen cover, frequency, and community composition. Burning the litter, which destroys much of the original community, results in a thin, scattered *Dicranum-Anthoceros* community. Raking the litter off the area results in a heterogeneous community with a large number of well-distributed species and a marked increase in cover and frequency.

Summary

1. Bryophyte and lichen communities on burned, raked, and undisturbed plots in a 55- to 67-year-old pine stand in the Piedmont of North Carolina were quantitatively sampled for frequency and cover.

2. The undisturbed plot had a thin, scattered *Plagiothecium-Dicranum-Leucobryum-Cladonia* community of six species (four mosses and two lichens).

3. The burned plot had a thin, scattered *Dicranum-Anthoceros* community. Cover on this plot was slightly greater than that of the undisturbed plot. The community had four species (two mosses, one lichen, and an *Anthoceros*). *Anthoceros* occurred only on this plot.

4. The raked plot had a well-distributed heterogeneous community of 16 species (seven mosses, two liverworts, and seven lichens).

5. Periodic litter removal seems to affect markedly the composition and cover of the terrestrial cryptogam community, with removal of the litter by raking having the most pronounced effect.

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FURTHER BRYOPHYTES FROM SHENANDOAH NATIONAL PARK, VIRGINIA

PAUL V. PRIOR[1]

The bryophytes of Shenandoah National Park were first described by Schnooberger and Wynne (1945). Their list contained 32 liverworts and 167 mosses, or a total of 199 species. The geology of the area, as well as its misuse before becoming a park, was adequately covered in their paper. A decade later some additions and corrections were made by Patterson (1955a). His review of the specimens deposited in the Park herbarium and at the University of Michigan led to a deletion of one liverwort and nine mosses from Schnooberger and Wynne's list. However, the number of bryophytes identified for the Park area was increased to 247 by Patterson's collection and identification of an additional 18 hepatics and eight mosses. Such a large number of species is not surprising when one considers the variety of habitats included within the 300 square miles of Park area. Numerous springs and deep, shady ravines as well as open woods and swamps provide adequate substrata for an abundance of bryophytes. The protection afforded the flora and fauna of the region by Park personnel and

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by natural deterrents to travel in certain areas offsets the heavy summertime traffic on the roads and foot trails. As a result the mosses and hepatics as well as their habitats go largely undisturbed and are being allowed to recover from the serious effects of lumbering, overgrazing, fire and farming. Only by periodic scrutiny of the area can the effects of active preservation be assessed and the range of these plants be ascertained.

During the summers of 1956, 1957 and 1958 I served as a ranger-naturalist at Shenandoah National Park. Numerous field trips into the lightly traveled sections of the park provided ample opportunity to study the flora of the region. With permission of the Park Superintendent, Mr. Guy D. Edwards, over 800 collections of bryophytes were made, mainly in the northern two-thirds of the Park. This section includes part of Warren, Page, Rappahanock, Madison, Rockingham and Greene Counties. Sites visited by Schnooberger and Wynne and by Patterson were avoided to some extent, although some overlapping exists where previously unreported species were noted and collected. Many collections were made at lower elevations, even on the limestone outcrops that are infrequently found.

Three additional species new for this region were recently sent me by Dr. F. J. Hermann of the U. S. Department of Agriculture, Beltsville, Maryland. He kindly granted me permission to include them in this report. They are *Anacamptodon splachnoides* (Froel.) Brid., *Fabronia ciliaris* (Brid.) Brid. and *Rhacomitrium aciculare* Brid.

The present paper reports the addition of five hepatics and 21 mosses to the bryophytic flora of Shenandoah National Park. This raises the total to 273, well over half the number found in the whole of Virginia to date. In an effort to list all the bryophytes noted in the literature and collected throughout the state of Virginia, Patterson (1949, 1950, 1951, 1953, 1955, 1955a) recorded a total of 497 species, including 132 hepatics and 365 mosses. Several species in the following list are new for the state. There is little doubt that numerous other bryophytes are to be found in the Park, and it is expected that a reduction in disturbance in many areas will favor their increase.

In the notations below the counties in which the collections were made are given in parentheses. With three noted exceptions the numbers cited are my own. Duplicate collections of my additions have been deposited in the herbaria at Shenandoah National Park and Texas Technological College, as well as my own personal collection. Those of Dr. Hermann have been deposited in the U. S. National Herbarium.

HEPATICEAE

Calypogeia trichomanis (L.) Corda. (Rappahanock). ¾ mile south of Jenkins Gap near Mount Marshall fireroad, 1203. Previously reported from Giles and Smyth Counties in the southwest corner of the state.

Frullania inflata Gottsche. (Rappahanock). On the base of an ironwood tree near the South Ford of the Jordan River about 1 mile east of North Marshall peak, 1209. Previously reported from Spotsylvania and Stafford Counties in east-central Virginia.

Pallavicinia lyellii (Hook.) S. F. Gray. (Madison). On rocks in a small stream near the Rapidan fireroad about 1 mile east of Big Meadows, 1201. Reported from Albemarle and Giles Counties in central and southwestern Virginia, respectively.

Metzgeria furcata (L.) Dum. (Rappahanock). On rocks in the headwaters of Sprucepine Branch about 1 mile south of Jenkins Gap, 1215. Reported from Giles County in southwestern Virginia.

Anthoceros laevis L. (Madison). Two collections from moist soil near the Rapidan fireroad about ½ and 1½ miles east of Big Meadows, respectively, 1171, 1195. Collections of this species are reported from Giles and Smyth Counties in southwest Virginia.

MUSCI

Sphagnum subsecundum Nees. (Page). Widely distributed in the Big Meadows Swamp at the origin of Hogcamp Branch Creek, 1192. Widespread in Virginia.

Dicranella rufescens (Sm.) Schimp. (Madison, Rappahanock). On rock and bark in Whiteoak Canyon about ½ mile above the upper falls, also collected on wood on Pass Mountain and at several stations on Mount Marshall fireroad, 1206, 1293, 1307. Grout, in his *Moss Flora*, reported collections of this species in Virginia.

**Dicranum scoparium* var. *sulcatum* Ren. & Card. (Madison). On moist soil in Whiteoak Canyon just above the upper falls, 1193. Probably widespread throughout the state, but this variety has not been noted before.

**Acaulon rufescens* Jaeg. (Rappahanock). On bare soil near the Rapidan fireroad about 2 miles east of Big Meadows, 1197. Although Grout (1928-40) reported this species as widespread east of the Rockies, it has not been reported from Virginia before.

Rhacomitrium aciculare Brid. (Madison). On wet soil along Hog Camp Branch, Dark Hollow Trail, *F. J. Hermann* 14382. Reported from Giles and Smyth Counties.

**Desmatodon obtusifolius* (Schw.) Jur. (Rappahanock). On soil near Skyline Drive at the entrance to Hazel Mountain fireroad, 1210. This species occurs across the northern part of the continent and has been reported as far south as Pennsylvania previously.

Ptychomitrium incurvum (Muhl.) Sull. (Madison). On rocks in a small tributary of the Rapidan River about 3 miles below Hoover Camp, 1203. Known from Giles County in the southwestern part of Virginia previously.

Brachythecium velutinum (Hedw.) BSG. (Rappahanock). On rocks in a stream near Mount Marshall fireroad about 1½ miles south of Jenkins Gap, 1291. Schnooberger and Wynne first reported this species from Madison County, but Patterson deleted it in 1955a.

Drepanocladus aduncus var. *kneiffii* (BSG.) Warnst. (Madison). In a

* New to the state.

small spring just above Whiteoak Canyon Falls no. 1, 1207. Other varieties of this species have been reported from Smyth and Giles Counties.

**Hygrohypnum dilatatum* (Wils.) Loeske. (Madison). On rocks in a small tributary of the Rapidan River about ½ mile north of Hoover Camp, 1195. Although new for Virginia, this species has been reported from cool mountain streams in West Virginia and northward.

Hygrohypnum novae-caesareae (Aust.) Grout. (Madison). On rocks in rapidly flowing water about 200 yards above the upper Whiteoak Canyon Falls, 1208. This species has been reported from Giles and Smyth Counties.

Hygrohypnum ochraceum (Turn.) Loeske. (Madison). On rocks in a small tributary of the Rapidan River about 3 miles below Hoover Camp, 1211. Previously reported from Giles County.

Leptodictyum riparium (Hedw.) Warnst. (Rappahanock). Collected in two sites: in a small tributary of Waterfall Branch about 1½ miles south of Jenkins Gap, 1198, and near the entrance to Hazel Mountain fireroad, 1431. Has been reported from numerous counties in Virginia.

Plagiothecium striatellum (Brid.) Lindb. (Madison). On bark of hemlock trees about 50 yards above Whiteoak Canyon Falls, 1221. Previously collected from Giles County.

Helodium paludosum (Sull.) Aust. (Rappahanock). On soil near the water reservoir on Pass Mountain, 1216, and on bark about 2½ miles north of Panorama crossroads near the Pass Mountain fireroad, 1306. Reported from most of the eastern counties.

Leskea arenicola Best. (Rappahanock). On bark of red oak at the entrance to Hazel Mountain fireroad, 1204. Previously reported from Prince George and Spotsylvania Counties.

Leskea gracilescens Hedw. (Madison, Rappahanock). Collected from several sites in both counties, 1217, 1321, 1358. Patterson (1950) reported this species as fairly common on tree trunks in the state.

Myurella sibirica (C.M.) Reim. (*M. careyana* Sull.) (Madison, Rappahanock). On wood in Dark Hollow about ½ mile below the falls and about 2½ miles north of Panorama crossroads on Pass Mountain fireroad, 1213. Previously reported from Albemarle, Giles, Rockbridge and Smyth Counties.

Thelia lescurii Sull. (Rappahanock). On soil near Hazel Mountain fireroad about ¼ mile east of Skyline Drive, 1218. Previously collected in Isle of Wight and Nansemond Counties.

Anacamptodon splachnoides (Froel.) Brid. (Madison). In a wet knothole, its typical habitat, in a red oak along a horse trail below the summit of Stonyman Mountain, *F. J. Hermann* 14858. Previously reported from Giles and Smyth Counties.

Fabronia ciliaris (Brid.) Brid. (Madison). On a dry ledge of greenstone bluff below the second falls in Whiteoak Canyon, *F. J. Hermann* 14838. Reported from Giles and Smyth Counties.

For their help in confirming and correcting the identification of some of my collections I wish to thank Dr. R. V. Drexler and Dr. Paul M. Patterson. Also, I am grateful to the personnel of Shenandoah National Park for granting me permission to collect and informing me of likely sites.

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"LICHENES EXSICCATI" IN HERBARIIS AMERICAE SEPTENTRIONALIS ASSERVATI

WILLIAM L. CULBERSON[1]

For the lichenologist and the bryologist, unlike the phanerogamic botanist, the concept of "Plantae Exsiccatae" transcends the connotation of its literal meaning of "dried plants." For us, an exsiccat is more precisely a collection of dried specimens issued in uniform sets with labels entirely printed. Traditionally the series is accompanied by a separate pamphlet edition of the labels. The "Cryptogamae Exsiccatae" are then a bridge between library and herbarium: botanical publications in which the illustrations are samples of the plants themselves. Because of the high reference value of cryptogamic exsiccats, most curators are loath to distribute the specimens throughout a general herbarium. For the lichens the inconvenience of using the separately stored collections is eliminated by Lynge's (1916-1939) almost exhaustive cross-index to all taxa issued as "Lichenes Exsiccati" through 1938.

In 1957 Duke University acquired the herbarium of the distinguished French lichenologist Monsieur l'Abbé J. Harmand. Although it was felt an obligation to catalogue at least the exsiccats in this long inaccessible herbarium, it was clear that a more valuable tool would result if the "Lichenes Exsiccati" of all North American herbaria were considered. Inventories were requested from the North American herbaria known or suspected to possess such specimens. Only two herbaria failed to report, but some of the holdings of one have been learned from other sources.

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The determination of the state of completeness of an exsiccat is excessively time-consuming if the specimens are distributed in a general herbarium. To minimize the curators' work in reporting collections, the following designations have been used:

c = collection complete.
ac = collection almost complete, *i.e.*, at least 90% of the numbers.
h = about half the numbers.
i = "incomplete"—a set known only to be incomplete.
s = scattered numbers, *i.e.*, less than 10% of the numbers.
r = "represented"—a set of unknown completeness.

In recording the total number of specimens issued and the number held by individual herbaria, data refer only to specimens of lichens. Lichenologically a herbarium may then have the "complete set" of an exsiccat of mixed cryptogams yet lack the bryophytes, fungi or algae issued in the same series. The catalog also lists a number of pre-1938 collections not included in Lynge.

The co-operating curators deserve sincerest thanks. For several herbaria the inventory presented a major task. I wish especially to thank Mrs. Maila Mackenzie Lamb for a long correspondence not only to record the holdings of the Farlow Herbarium but also to establish publication data for certain sets. Long inventories were also prepared by Mrs. Mary Fleming (NY), Miss Billie Jean Holman (DUKE), Mrs. Joyce H. Jones (MICH), Dr. John A. Stevenson (BPI) and Miss Isabelle Tavares (UC).

The herbaria are designated by abbreviations:

BPI—National Fungus Collections, Beltsville, Md.
CAN—National Museum of Canada, Ottawa.
CM—Carnegie Museum, Pittsburgh 13, Penna.
COLO—University of Colorado, Boulder.
COLO-ABS—University of Colorado (American Bryological Society Herbarium).
DUKE—Duke University, Durham, N. C.
DUKE-C—Duke University (W. L. Culberson Herbarium, private).
FH—Farlow Herbarium, Harvard University, Cambridge, Mass.
Herre, A. W. (private herbarium), 507 Caledonia St., Santa Cruz, Calif.
ILL—University of Illinois, Urbana.
ISC—Iowa State College, Ames.
Kiener, W. (private herbarium), 1242 Pawnee St., Lincoln, Nebr.
KSC—Kansas State College of Agriculture and Applied Science, Manhattan.
MASS—University of Massachusetts, Amherst.
MICH—University of Michigan, Ann Arbor.
MO—Missouri Botanical Garden, St. Louis.
MSC—Michigan State University, East Lansing.
MT—Université de Montréal, Montréal, Canada.
NY—New York Botanical Garden, New York.
OC—Oberlin College, Oberlin, Ohio.
PH—Academy of Natural Sciences, Philadelphia, Penna.
TAES—Texas A. and M. College, College Station.

TENN—University of Tennessee, Knoxville.
TRT—University of Toronto, Toronto, Canada.
UC—University of California, Berkeley.
US—U.S. National Museum (Smithsonian Institution), Washington, D. C.
WELC—Wellesley College, Wellesley, Mass.
WIS—University of Wisconsin, Madison.
WIS-T—University of Wisconsin (J. W. Thomson Herbarium, private).
WS—State College of Washington, Pullman.
WTU—University of Washington, Seattle.
WVA—West Virginia University, Morgantown.
YU—Yale University, New Haven, Conn.

Of the 164 series of "Lichenes Exsiccati" issued thus far, 122 (74%) are represented, at least partially, in North America. In all this catalog gives the location of an estimated 70,000 specimens of "Lichenes Exsiccati."

THE COLLECTIONS

ABBAYES, H. DES. *Lichens Armoricani Spectabiles Exsiccati.* (1-120).—BPI, 61-120.

———. *Lichenes Gallici et Nonnulli Alii Exsiccati.* (1-60).—BPI, c.

ALMBORN, O. *Lichenes Africani.* (1-25, to be continued).—FH, c; MICH, c; MSC, c; US, c; WIS-T, c.

ANZI, M. *Cladoniae Cisalpinae Exsiccatae.* (1-28b).—FH, 28b; NY, r.

———. *Lichenes Exsiccati Minus Rari Italiae Superioris.* (1-400).—FH, i; NY, r.

———. *Lichenes Etruriae Rariores Exsiccati.* (1-53).—FH, i; NY, r.

———. *Lichenes Prov. Sondriensis, et Novo Comensis Exsiccati.* (1-288).—NY, r.

———. *Lichenes Rariores Langobardi Exsiccati.* (1-578).—FH, i; NY, r.

———. *Lichenes Rariores Veneti.* (1-175).—FH, i; NY, r.

ARNOLD, F. *Lichenes Exsiccati.* (1-1800).—DUKE, ac; FH, i; NY, r; US, r.

———. *Lichenes Monacenses Exsiccati.* (1-530).—FH, c; MICH, r.

BALANSA, B. *Plantes du Paraguay.* (131 numbers).—FH, c.

BARTH, J. *Herbarium Transsylvaticum.* (1-50).—NY, r.

BAXTER, W. *Cryptogamous Plants (Stirpes Crypt. Oxonienses).* (19-22, 69-73).—NY, c.

BOHLER, J. *Lichenes Britannici.* (1-128).—FH, c; NY, r. [Lynge lists "Fasciculi I-XV, nos. 1-120" but Mrs. Maila Mackenzie Lamb (FH) finds Fasc. XVI or a total of 128 specimens.]

BREUTEL, C. *Flora Germanica Exsiccata. Ser. II. Cryptogamia.* (13, 101-120, 201-205, 301-310, 401-413).—FH, c.

BRITZELMAYR, M. *Lichenes Exsiccati.* (1-1012).—FH, i; MICH, 265 numbers.

CLAUDEL, H. et V. et J. HARMAND. *Lichenes Gallici Praecipui Exsiccati.* (1-550).—BPI, c; FH, c.

CLEMENTS, F. E. et E. S. *Cryptogamae Formationum Coloradensium.* (89-111, 303-310, 519-522).—FH, c; NY, r; OC, c; UC, c.

COEMANS, E. *Cladoniae Belgicae Exsiccatae.* (1-200).—NY, r.

CRETZOIU, P. *Lichenes Romaniae Exsiccati.* (1-70).—FH, c; US, r.

CUMMINGS, CLARA. *Decades of North American Lichens.* (1-360).—CM,

s; COLO, s; COLO-ABS, s; DUKE-C, ac; FH, c; ILL, c; ISC, r; Kiener, h; KSC, ac; MASS, h; MICH, s; MSC, r; NY, i; OC, c; UC, s; US, c; WELC, c; WIS, c.

——— *et al. Lichenes Boreali-Americani, Second Edtion of Decades of North American Lichens.* (1-280).—CM, ac; COLO, 53 numbers; COLO-ABS, s; DUKE-C, ac; FH, c; MICH, c; MSC, r; NY, r; PH, s; US, c; WELC, c; WIS, i.

DELISE, D. *Lichens de France.* (1-25).—DUKE, c; FH, c.

DESMAZIÈRES, J. B. H. J. *Plantes Cryptogames du Nord de la France.* [Ed. I. Title becomes *Plantes Cryptogames de France* in later fascicles.] (108 numbers).—BPI, c; DUKE, the last 95 numbers; FH, c; NY, r.

———. *Plantes Cryptogames de France.* [Ed. II, ser. I.] (159 numbers).—BPI, c; FH, c; NY, r.

———. *Plantes Cryptogames de France.* [Ed. II, ser. II.] (116 numbers).—DUKE, c; FH, c; NY, r.

DICKSON, J. *Hortus Siccus Britannicus.* (40 numbers).—FH, Fasc. 1-19 (= 31 numbers).

DIETRICH, D. *Sammlung deutscher Laubmoose, Lebermoose und Flechten.* (about 100 lichens).—NY, c.

DUFFT, A. *Cladonien von Flora Germanica.* (1-150).—FH, c.

ELENKIN, A. *Lichenes Florae Rossiae et Regionum Confinium Orientalium.* (1-200).—FH, 1-150; MICH, r.

Erbario Crittogamico Italiano. [Ser. I.] (371 numbers).—FH, 30 numbers.

———. [Ser. II.] (173 numbers).—BPI, Fasc. XIX-XXX (= the last 35 numbers); FH, 30 numbers; NY, r.

FARLOW, W. G. See *Reliquiae Farlowianae.*

FELLMAN, N. I. *Lichenes Arctici, Collecti Aestate 1863 in Lapponia Orientali.* (1-224).—FH, c; NY, r.

FLAGEY, C. *Lichenes Algerienses.* (1-307).—FH, 1-200.

———. *Lichens de Franche-Comté, et de Quelques Localités Environnantes.* (1-450).—DUKE, c; FH, c.

Flora Exsiccata Austro Hungarica, a Museo Botanico Universitatis Vindobonensis Edita. (175 numbers).—FH 3515-3535; WELC, r.

Flora Hungarica Exsiccata a Sectione Botanica Musei Nationalis Hungarici Edita. (11-20, 111-120, 211-220, 311-320, 411-420, 511-520, 611-620, 711-720, 811-820, 911-920).—CAN, 811-920; FH, 30 s; MICH, 411-920; UC, ac; US, r.

FÓRISS, F. *Lichenes Bükkenses Exsiccati.* (1-80).—FH, c; WELC, r; WVA, r.

FRIES, E. M. *Lichenes Sueciae Exsiccati.* (1-420).—CAN, s; DUKE, 1-11, 13-33, 35-64, 66-182, 184-257, 260-300, 361-420; FH, c; MSC, 1-10, 12-22, 24-26, 28-30, 121-180, 271-300; US, r.

FRIES, TH. M. *Lichenes Scandinaviae Rariores et Critici Exsiccati.* (1-75).—FH, c; MSC, 26-75; NY, r.

FUNCK, H. C. *Cryptogamische Gewächse des Fichtelgebirg's.* [Ed. I.] (162 numbers in 42 "Heften").—BPI, Heften 1-23 (= 86 numbers); DUKE, Heften 6-39 (= 134 numbers); FH, c; MICH, r.

———. *Cryptogamische Gewächse des Fichtelgebirg's.* [Ed. II.] (25 numbers).—DUKE, c; FH, c. [The rest of the second edition (*i.e.*, Heften 6-42) is identical to the first edition.]

GYELNIK, V. *Lichenotheca.* (1-200).—FH, i; WELC, r.

HALE, M. E., JR. *Lichenes Americani Exsiccati.* (1-75, to be continued).—BPI, c; CAN, c; COLO, c; DUKE-C, c; FH, c; Herre, c; ILL, c;

MO, c; MSC, c; MT, c; NY, c; TENN, c; TRT, c; UC, c; US, c; WIS-T, c; WTU, c; WVA, 1-25; YU, c.

HARMAND, J. *Lichenes Gallici Rariores Exsiccati.* (1-150).—DUKE, c; FH, c.

———. *Lichenes in Lotharingia.* (about 406 nonconsecutively numbered entries, many including several infraspecific taxa).—DUKE, ac; FH, c.

[———.] *Guide Elémentaire du Lichénologue.* (1-120).—BPI, c; DUKE, 1-88, 90-120; FH, c; MT, c.

HASSE, H. E. *Lichenes Exsiccati ex Herb. Dr. H. E. Hasse Relicti.* (1-250).—BPI, c; CM, ac; COLO-ABS, ac; NY, r; OC, c; US, r; WELC, r.

HAVAAS, J. J. *Lichenes Norvegiae Occidentalis Exsiccati.* (1-300).—COLO, 101-125, 151-300; FH, c.

HEPP, P. *Die Flechten Europas, in getrockten mikroskopisch untersuchten Exemplaren mit Beschreibung und Abbildung ihrer Sporen.* (1-962).—DUKE, 1-462; FH, i; NY, c.

HOWE, R. H., JR. *Lichenes Novae Angliae.* (1-70).—CM, ac; MICH, r; NY, r; WELC, r.

JACK, J. B., L. LEINER und E. STIZENBERGER. *Kryptogamen Badens.* (205 numbers).—FH, c; NY, r.

KAVINA, K. et A. HILITZER. *Cryptogamae Cechoslovenicae Exsiccatae, Editae ab Instituto Botanico Polytechnici Pragensis.* (21-40, 71-80, 141-170, 261-280).—FH, c; NY, c.

KOERBER, G. W. *Lichenes Selecti Germanici.* (1-420).—FH, i; NY, r.

KRAWIEC, F. *Lichenotheca Polonica.* (1-100).—FH, c.

Kryptogamae Exsiccatae Editae a Museo Palatino Vindobonensi. (41-70, 151-180, 241-270, 351-380, 441-470, 551-580, 651-670, 751-770, 861-880, 1021-1060, 1221-1260, 1351-1370, 1521-1560, 1641-1670, 1761-1780, 1851-1880, 1951-1980, 2051-2080, 2151-2180, 2261-2290, 2341-2370, 2441-2470, 2551-2580, 2741-2780, 2841-2870, 2951-2970, 3051-3070, 3141-3170, 3471-3480, 3571-3580, 3621-3670, 3711-3730, 3811-3830, 3911-3920, 4011-4020, to be continued).—BPI, "Decades 1-159"; COLO, 460 numbers with 2151-4020 ac; DUKE, s + 351-770, 861-875, 877-2080; FH, c; NY, "Decades 1-41"; TRT, h; UC, "Centuries 22-26, 28-38" + s; US, r; WELC, r. [The excessively complicated original designations (by "centuries," "decades" and numbers) of the whole exsiccat preclude more precise inventory from the herbaria. The numbers after the title, however, seem to represent all lichens thus far issued.]

LARBALESTIER, C. DU B. *Lichenes Caesarienses et Sargienses Exsiccati.* (1-100).—NY, r.

LEIGHTON, W. A. *Lichenes Britannici Exsiccati.* (1-410).—DUKE, 1-200; FH, r; NY, r.

LIBERT, A. *Plantae Cryptogamae.* (24 numbers).—FH, c.

LINDIG, A. *Lichenes Novo-Granatenses.* (700-761, 2500-2898).—FH, c.

LOJKA, H. *Lichenes Regni Hungarici.* (1-200).—COLO, s; DUKE, 190 numbers; FH, c; NY, r; PH, r; US, r; WS, 160 numbers.

———. *Lichenotheca Universalis.* (1-250).—COLO, s; DUKE, 31 numbers; FH, ac; MICH, c; NY, r; US, r; WELC, r.

MACOUN, J. *Canadian Lichens.* (1-200).—CAN, c; DUKE, r; DUKE-C, ac; FH, c; NY, r; OC, c; UC, 116 numbers; US, r; WELC, r. [This series is not properly an exsiccat because some numbers are made up of more than one collection. It is included here because it is nevertheless commonly cited in the American literature.]

MAGNUSSON, A. H. *Lichenes Selecti Scandinavici Exsiccati.* (1-425).—

BPI, Fasc. I-VII, XIV-XVII (= 275 numbers); CAN, r; COLO, s; MICH, r; MO, r; TRT, 176-425; WIS, i; WVA, r.

MALBRANCHE, A. *Lichens de Normandie, Préparés et Classés d'après la Méthode du dr. Nylander.* (1-400).—DUKE, 1-46, 48-51, 53-141, 143-334, 336-400; FH, c.

MALME, G. O. A:N. *Lichenes Suecici Exsiccati.* (1-1000).—COLO, c; FH, c; NY, 1-325; WIS, s.

——— [et R. SANTESSON]. *Lichenes Austroamericani ex Herbario Regnelliano.* (1-475). [Last fascicles by R. Santesson.]—FH, c; MICH, r; MSC, c; UC, 25 s; WIS, i.

MANDON, G. *Lichens de Madère.* (1-98?).—FH, c?.

MASSALONGO, A. B. *Lichenes Italici Exsiccati.* (1-360).—FH, c; NY, c.

MERESCHKOWSKY, C. *Lichenes Rossiae Exsiccati.* (1-75).—DUKE, c; Kiener, c.

———. *Lichenes Ticinenses Exsiccati.* (1-102 + suppl. 1-7).—FH, 1-102 + suppl. 1-5; NY, r.

MERRILL, G. K. *Lichenes Exsiccati.* (1-275).—BPI, c; CM, ac; DUKE-C, ac; MICH, c; NY, r; PH, r; US, c; WTU, s; WVA, c.

———. *Lichenes Exsiccati.* [Ser. II.] (1-150).—BPI, c; CAN, c; COLO, s; CM, r; DUKE-C, ac; NY, r; US, c.

MIGULA, W. *Cryptogamae Germaniae, Austriae et Helvetiae Exsiccatae.* (1-350).—FH, c; MICH, 1-150; MSC, 1-150, 276-313; NY, c; OC, c.

MOUGEOT, J. B. et C. NESTLER. *Stirpes Cryptogamae Vogeso-Rhenanae.* (57-74, 152-173, 249-265, 342-365, 441-473, 540-557, 633-651, 736-757, 837-859, 938-957, 1040-1069, 1144-1162, 1234-1240, 1325-1333, 1424-1445).—BPI, 57-1333; FH, c; NY, c; UC, 57-757.

MUDD, W. *Lichenes Britannici Exsiccati.* (1-301).—DUKE, 200 numbers; FH, c; NY, c.

———. *A Monograph of British Cladoniae, Illustrated with Dried Specimens of Eighty Species and Varieties.* (1-80).—FH, c; NY, r.

NÁDVORNÍK, J. *Caliciaeae Exsiccatae.* (1-40).—FH, c.

NORRLIN, J. P. et W. NYLANDER. *Herbarium Lichenum Fenniae.* (1-807).—FH, 201-450.

NYLANDER, W. *Herbarium Lichenum Parisiensium.* (1-150).—DUKE, c; FH, 1-121.

———. *Lichenes Mont-Dorienses.* (1-70).—DUKE, c. [Lynge quotes Bouly de Lesdain's remarks that Harmand's designation of the series as containing 111 specimens, rather than 70, is wrong. Harmand's own set does contain numbers 71-111 but with labels in Nylander's handwriting rather than in print.]

———. *Lichenes Pyrenaeorum Orientalium.* (1-78).—FH, c.

OLIVIER, H. *Herbier des Lichens de l'Orne et du Calvados.* (1-450).—DUKE, c.

PETRAK, F. *Flora Bohemiae et Moraviae Exsiccata.* (1-150).—FH, c; WVA, r.

PICQUENARD, C. A. *Lichens du Finistère.* (30 nonconsecutive numbers).—NY, r.

POELT, J. *Lichenes Alpium et Regionum Confinium.* (1-60, to be continued).—COLO, 21-60; FH, c; US, c.

RABENHORST, L. *Cladoniae Europaeae. Die Cladonien Europas in getrockneten Exemplaren.* (Contents not determinable from available literature).—Kiener, "about two-thirds the specimens"; MICH, 253 specimens.

———. *Die Cladonien Europas in getrockneten Exemplaren. Supplementum I.* [All published.] (about 60 numbers?).—FH, c?.

———. *Lichenes Europaei Exsiccati.* (1-974).—FH, i; MICH, 102-967; MSC, 55 numbers; NY, r; US, 1-200; WELC, r.

RÄSÄNEN, V. *Lichenes Fenniae Exsiccati.* (1-1000).—BPI, 1-750; MICH, 85 numbers; NY, c; UC, 1-500.

———. *Lichenotheca Fennica.* (1-750).—COLO, 1-150, 301-750; TRT, 151-375, 451-525; UC, 1-150, 451-525; US, 601-750.

REHM, H. *Ascomycetes Exsiccati.* (10 numbers).—MICH, c.

———. *Cladoniae Exsiccatae.* (1-440).—FH, c; NY, c.

REICHENBACH, H. G. L. et C. SCHUBERT. *Lichenes Exsiccati.* (1-150).—NY, r.

Reliquiae Farlowianae. (451-490, 648-657).—FH, c; NY, 451-490; UC, ac; WELC, r.

Reliquiae Tuckermanianae. (1-150).—COLO, 100-150; DUKE-C, c; FH, c; Herre, c; MICH, c; NY, c; TENN, ac; TRT, c; UC, ac; US, c; WELC, r; WIS, c; WIS-T, c.

ROUMEGUÈRE, C. Lichenes [Selecti] Gallici Exsiccati. [Title varies.] (1-600).—DUKE, 412 numbers; NY, c; OC, r.

SANDSTEDE, H. *Cladoniae Exsiccatae.* (1-1886).—DUKE-C, 437 numbers; FH, c; MICH, c; NY, r; WELC, r; WTU, s; WVA, c.

SANTESSON, R. See Malme, G. O. A:n. [et R. Santesson].

SAVICZ, V. P. *Lichenotheca Rossica, Regionibus Confinis Completa.* (1-80, to be continued).—BPI, 1-30; COLO, 6, 11-70; DUKE, 6-14, 21-23, 26-29, 31-70; MICH, 1-20; US, 11-60; WIS-T, 1-20.

SCHADE, A. *et al. Lich[enes] Sax[onici] Exs[iccati].* (1-540).—FH, c; WELC, r; WVA, c.

SCHAERER, L. E. *Lichenes Helvetici Exsiccati.* (1-650).—DUKE, c; FH, c; MASS, c; MICH, s; NY, c; UC, 1-153.

SMALL, J. K. *Lichens of Eastern North America.* (1-38).—BPI, c. [Dr. J. A. Stevenson (BPI) writes: "The labels are printed . . . In his correspondence with us, Mr. Small stated that he planned to continue to issue the series." Not listed by Lynge; probably in other North American herbaria but overlooked.]

SOMMERFELT, S. C. *Plantae Cryptogamae Norvegiae.* (42-76, 127-164).—FH, c; NY, r.

SPRUCE, R. *Lichenes Amazonici et Andini.* (about 500 nonconsecutively numbered specimens).—NY, r.

STENHAMMAR, C. *Lichenes Sueciae Exsiccati.* (1-240).—BPI, 181-240; CAN, 211-212; COLO, 181-240; FH, c; MICH, c; MSC, 181-240; NY, r.

SUZA, J. *Lichenes Bohemoslovakiae Exsiccati.* (at least 1-200).—BPI, c?; COLO, 53 numbers; FH, 1-60.

TAVARES, C. N. *Lichenes Lusitaniae Selecti Exsiccati.* (1-100, to be continued).—COLO, s; FH, c; TENN, 30 numbers; US, ac; WIS-T, c.

THOMSON, J. W. *Lichenes Wisconsinenses Exsiccati.* (1-80, to be continued).—BPI, c; CAN, i; COLO, h; DUKE-C, c; FH, 1-60; MICH, c; MSC, r; NY, c; TAES, h; US, c; WELC, r; WIS, c; WIS-T c.

TOBOLEWSKI, Z. *Zielnik Porostów Polski. Lichenotheca Polonica.* (1-200, to be continued).—COLO, 101-146, 148-192, 194-200; DUKE, 101-200; FH, c.

TREVISAN, V. *Lichenotheca Veneta.* (at least 1-366).—FH, 73 numbers.

TUCKERMAN, E. *Lichenes Americae Septentrionalis Exsiccati.* (1-150).—FH, c; MASS, c; MICH, 1-100; MO, c; NY, c; PH, c; TENN, h.

———. See also *Reliquiae Tuckermanianae.*

VAINIO, E. A. *Lichenes Brasilienses.* (at least 1-1593).—FH, 470 specimens.

VĚZDA, A. *Lichenes Bohemoslovakiae Exsiccati, Editi ab Instituto Botanico Universitatis Agriculturae et Silviculturae, Brno, ČSR.* (1-270, to be continued).—COLO, 1-240; DUKE, c; FH, 1-180; MSC, 1-180; US, 1-150; WIS-T, 1-150.

WAGNER, H. *Cryptogamen Herbarium.* (1-25).—FH, c; NY, c.

WARTMANN, B. *et al. Schweizerische Kryptogamen.* (51-75, 151-175, 251-275, 351-370, 451-480, 551-575, 651-675, 736-755, 833-841).—FH, c; NY, c.

WELWITSCH, F. *Cryptotheca Lusitanica.* (1-123).—FH, c; NY, r.

WESTENDORP, G. B. *Herbier Cryptogamique Belge.* (at least 154 numbers).—FH, c?; NY, 1314-1369; UC, the first 31 numbers.

WRIGHT, C. *Graphideae Cubenses.* (at least 1-267b).—FH, c?; MICH, r; PH, s.

———. *Lichenes Insulae Cubae.* (at least 1-244).—FH, c?; NY, r; US, r.

ZAHLBRUCKNER, A. *Lichenes Rariores Exsiccati.* (1-385).—BPI, 188-311; FH, i + 301-385; MICH, 74 numbers; NY, r.

ZWACK-HOLZHAUSEN, W. VON. *Lichenes Exsiccati.* (1-1177).—DUKE, 170 early numbers; FH, c.

LITERATURE CITED

LYNGE, B. 1915-1918. Index specierum et varietatum Lichenum quae collectionibus "Lichenes Exsiccati" distributae sunt. Pars I. Nytt Mag. for Naturvidensk. Vol. 53-54, 55-56. 1-599 pp.

———. 1920-1922. Index specierum et varietatum Lichenum quae collectionibus "Lichenes Exsiccati" distributae sunt. Pars II. *Ibid.* Vol. 57-60. 1-316 pp. [The consecutively paged reprinted editions of Parts I-II cited here are commoner in herbaria than the originals.]

———. 1939. Index collectionum "Lichenes Exsiccati." Supplementum I. [all published]. *Ibid.* 79: 233-323.

EPIPHYLLOUS HEPATICAE IN THE SOUTHERN APPALACHIANS

RUDOLF M. SCHUSTER[1]

Very few occurrences of epiphyllous bryophytes have been reported within the borders of the United States; these reports have referred almost exclusively to central and southern Florida (Schuster & Anderson, 1955; Schuster & Hattori, 1954; Schuster, 1955, 1955a, 1956, 1957). Since the publication of Schuster and Anderson (1955), I have seen a sparse collection of *Lejeunea cardoti* Steph. from the fronds of *Sabal* in coastal Louisiana (Crown Point, 3 miles S. of the Mississippi R., Jefferson Parish, *L. F. Koch* 7881). The relatively few examples of epiphylly in the United States have all been noted from the tropical portions of Florida, south of Miami, with the following exceptions: (1) Hills-

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borough River State Park, Hillsborough Co., Florida (*Diplasiolejeunea rudolphiana* epiphyllous on *Serenoa repens*, associated with *Cololejeunea minutissima, Leptocolea cardiocarpa, Frullania obcordata, F. kunzei, Lejeunea flava, L. longifissa, L. bullata, Leucolejeunea conchifolia, Aphanolejeunea cornutissima; Diplasiolejeunea rudolphiana* on *Sabal palmetto*, with *Leptocolea, Leucolejeunea conchifolia, Lejeunea laetevirens* and *Cololejeunea minutissima*); (2) Alexander Springs, Lake Co., Florida (*Diplasiolejeunea, Leptocolea*, on leaves of *Ilex cassine*); (3) Annuttalagga Hammock, Hernando Co., Florida (*Cololejeunea diaphana* var. *cristulata, C. contractiloba* and *Leptocolea*, on fronds of *Trichomanis petersii*); (4) Gold Head Branch State Park, Clay Co., Florida (*Leptocolea* on leaves of *Laurocerasus caroliniana, Magnolia grandiflora, Persea borbonia, Raphidophyllum hystrix, Serenoa repens*); (5) Juniper Springs, Marion Co., Florida (*Leptocolea*, on leaves of *Gordonia lasianthus, Serenoa repens, Sabal palmetto, Ilex cassine*, etc.); (6) Big Tree County Park, Seminole Co., Florida (*Leptocolea* on leaves of *Raphidophyllum hystrix*); (7) Appalachicola River bluffs, below Torreya State Park, Liberty Co., Florida (*Leptocolea*, traces, on leaves of *Kalmia latifolia* and *Quercus nigra*).

Of these seven stations, all north of the tropical tip of Florida, only the last is from a region without marked tropical or subtropical affinities. The third of the cited reports, of plants from the leaves of *Trichomanis*, is of relatively slight significance, since epiphytism on filmy ferns is common in the Southern Appalachian gorges. The epiphyllous occurrence of Hepaticae several feet above ground level, on the leaves of woody angiosperms, in the Southern Appalachians, is, however, a matter of extraordinary interest since this area is far removed both from the Coastal Plain, from which all previous occurrences have been noted, and from the tropics and subtropics.

Epiphyllous Hepaticae have been seen, so far, at a single site in the escarpment region of the Southern Appalachians. On August 24, 1958, the author investigated a small but steeply cascading western tributary of the Whitewater River, which enters the Whitewater River just below the wooden bridge crossing the river about 0.5-0.6 mi. below the Lower Falls. This station lies about 2 mi. above Jocassee, Oconee Co., South Carolina, and between 2-3 mi. south of the North Carolina border, at an elevation of about 1000-1250 ft. The tributary is notable in possessing steep sides, in part formed by large boulders, in part by vertical rock walls. At several places, large sheets of the filmy fern, *Trichomanis petersii*, occur, and a variety of bryophytes restricted

to the very moist and shaded sites are consociated, among them *Radula sullivantii, Dumortiera hirsuta, Jubula pennsylvanica, Calypogeia portoricensis* and *Mnium carolinianum*. This cascading stream is deeply shaded by overarching *Leucothöe editorum* (*L. catesbyi*) and *Rhododendron maximum*. Although no measurements of the microclimate are available, extremely low light intensity, high temperature and exceptionally high humidity were noted. Indeed, it seems worthwhile to emphasize that one reason epiphyllous Hepaticae were found at this site is that as soon as the small gorge was investigated, the climatic conditions "seemed right" and the writer was psychologically prepared to find the plants as epiphytes. Such an explanation may seem feeble to one who has not collected epiphyllous hepatics in the tropics and subtropics; one who has had this experience, however, will surely recognize the fact that the peculiar environmental conditions associated with epiphylly are real and palpable ones. Of these conditions, deep shade and oppressively high humidity are the most notable.

At the Whitewater Gorge station, the epiphyllous liverworts were confined to a small area of some 50-60 sq. ft., but they occurred there on the majority of older leaves, both of *Rhododendron maximum* and *Leucothöe editorum*. They were much more common on the leaves of *Rhododendron*. Both the *Leucothöe* and *Rhododendron* possess "drip-tips," which were very often rather densely carpeted with Hepaticae. However, there was no sharp restriction to the leaf tips of these shrubs. Most colonies of liverworts were found at a level of 1.5-4 ft. above the stream bed; above four feet there appeared to be a sufficient drop in humidity to act as a limiting factor.

Three species of Hepaticae were found, of which only one, **Cololejeunea cardiocarpa** (Mont.) comb. n.,[2] was frequent. The other two species, *Frullania obcordata* L. & L. and *Drepanolejeunea bidens* Steph.,[3] occurred as single individuals. The widespread occurrence of *Cololejeunea cardiocarpa* on the leaves of a wide variety of plants has already been noted (Schuster, 1955, p. 147).

The occurrence of epiphylly in this region is of more than intrinsic interest, since it fits well within the general concept that

[2] *Lejeunea cardiocarpa* Mont. *in* Ramon de la Sagra, Hist. Fis. Pol. y Natur. Cuba. 9: 476, *pl.* 18, *f.* 4. 1845=*Leptocolea cardiocarpa* Evans, Bull. Torrey Bot. Club 38: 268, *pl.* 12, *f.* 1-3, 1911. There seems no remaining doubt that *Leptocolea* cannot be maintained as more than a subgenus of *Cololejeunea*.

[3] The *Drepanolejeunea* is the Appalachian plant now ascribed to *D. bidens*. However, a well-marked subspecies, so far unnamed, is involved.

the moist escarpment gorges have served as a major refugium for delicate and, in part, tropical species. In other conjunctions, the writer is reporting on the occurrence in this general region of a variety of other tropical species which have heretofore been reported no closer to the Appalachian Mountains than the outer Coastal Plain, or Central and Southern Florida, or even the West Indies. Among these are *Calypogeia portoricensis, Dumortiera nepalensis, Metzgeria uncigera* and *Frullania kunzei* and *obcordata,* of which *Calypogeia portoricensis* has not been previously reported north of the West Indies; *Dumortiera nepalensis* has been found a few times in central Florida and once in southern Georgia; *Metzgeria uncigera* has been reported from central Florida westward to coastal Mississippi and *Frullania kunzei* and *obcordata* from the Coastal Plain of southeastern Virginia to southern Florida and Louisiana. The occurrence, in the Whitewater River gorge, of the "old tropical" fern, *Asplenium monanthes,* is obviously another link in the history of persistence in isolated sites within the escarpment gorges. Of equal significance is the occurrence of the hepatic, *Lophocolea muricata,* in the Whitewater River gorge, where it was collected in 1958 both on the North and South Carolina portions. This pantropical species occurs in only three of the southern escarpment gorges—the Saluda River, where it was found by Mrs. Bayard Taylor; the Chattooga River, where I collected it in 1957 and 1958; and the Whitewater River gorge, where several collections were made in 1958.

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PHASCUM FLOERKEANUM IN ONTARIO

Harry Williams[1]

Phascum floerkeanum Web. & Mohr is a widely distributed species of bare calcareous soil in Europe, and was to be expected in North America. Grout (1939) failed to locate an American

[1] Millbrook, Ontario, Canada.

specimen; the few collections ascribed to this species he considered to be immature forms of *Phascum cuspidatum*. However, *P. floerkeanum* has now been established as occurring in its typical expression in three counties of southern Ontario. It almost certainly has a wider distribution in the lower lakes area, and should be looked for in adjacent parts of the United States.

The species was first identified in Ontario in a collection from a stubble field west of Millbrook, Durham Co., April 22, 1958, where it grew with abundant *Phascum cuspidatum* and *Barbula convoluta*. The first Ontario collection is probably that made by Roy F. Cain, October 29, 1955, on sandy soil in a hay-field, Nashville, York Co. (TRT). In the fall of 1958 some 20 collections were made by the author: from five additional sites in the Millbrook area; from an additional site near Nashville, York Co., with Dr. Cain; and from one site in Northumberland Co., ten miles east of Millbrook. Habitats were stubble fields (3), old fields (2), old roads or field paths (2), and soil-wash deposits (2), all on soil over calcareous parent material. The two associates mentioned above were perhaps the commonest: others seen included *Ephemerum cohaerens*, *E. spinulosum*, *Pottia truncata*, *P. davalliana*, and in two small occurrences near Millbrook, *Pterygoneurum ovatum*.

Robust plants of *P. floerkeanum* are only about 1.0-1.2 mm. high, but they stand out in the field by virtue of their red-brown color when mature and their habit of occurring on small patches of compact soil bare of other mosses. On drier soils the plants are slender and smaller, as short as 0.5 mm., and scattered singly; the typical plants are seen on moister, but still well-drained soils, where small clusters of up to 100 or more may occur. In 1958, capsules were mature from mid-October on, with many plants still immature at freeze-up in late November. Observations in the spring of 1958 showed that the later plants mature the following spring, and that many of the mature plants also persist over winter, though with no functional connection with the soil. Jones (1953) and Proctor (1956) have noted that in southern England the plants have usually disappeared by November.

According to the description in Dixon (1924), the Ontario plants are quite typical, except that the leaf margins seem to be revolute throughout. Mature plants present no difficulty in determination; they key to *P. cuspidatum* in Grout (*l.c.*), but are amply distinguished by the reddish coloration, the much smaller size, and, under the microscope, the narrower leaf-cells (13-15 μ). Stunted plants of *P. cuspidatum* may be fully as small as *P. floerkeanum*, but the leaves of the former species have a noticeably

thicker look under a binocular dissecting microscope, owing to the larger cells, and the two are generally separable on this basis. Other salient differences between the two species are as follows: *P. cuspidatum* soon branches to form small tufts; does not usually mature locally before April or May; behaves as a quasi-perennial, persisting through the summer in most places; and is a common and abundant plant. *P. floerkeanum* is almost invariably unbranched; regularly matures in autumn; is strictly an ephemeral species; and is much more local and less abundant.

Duplicates of some of the author's collections are in the herbaria of the National Museum of Canada and the University of Toronto. His no. 1421, from Millbrook, has been distributed to several American herbaria, including that of the American Bryological Society.

The author expresses his thanks to Messrs. E. C. Wallace and A. C. Crundwell, for confirming the original determination, and to Dr. R. F. Cain, for the loan of specimens.

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BRYOPHYTES OF SOUTHWEST MISSOURI. I. NEW DISTRIBUTION RECORDS

PAUL L. REDFEARN, JR.[1]

In the most recent checklist of the bryophytes of Missouri (Gier, 1955), distribution data for a number of species were entirely lacking. Consequently, these species were not included as definite members of the state flora. As a result of my recent field work in southwest Missouri, distribution data for three of these species, as well as one new state record, may now be reported. Voucher specimens of the collections cited below have been deposited in the herbarium of the University of Tennessee.

BARBULA BESCHERELLEI Sauerb. Very abundant on flat, exposed limestone rocks which appeared to be frequently inundated.

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Small ravine *ca.* 4 mi. south of Springfield, Greene Co. (3293, det. by H. A. Crum and E. B. Bartram). Dr. Crum indicated that had this collection come from the southwestern United States or Mexico he would not have any reservations about his determination, particularly since *B. acuta* (Brid.) Brid. is not known to approach this Missouri material in size. Therefore, at his suggestion, duplicate material was sent to Mr. Bartram, who wrote that he could find no excuse for questioning Crum's determination. The occurrence of this species in Missouri is noteworthy for it constitutes an addition to the list of Mexican Highland species found in the Ozark Highlands.

EUCLADIUM VERTICILLATUM (Brid.) BSG. Forming extensive mats on exposed limestone rocks along steep bluffs above James River just below Lake Springfield, Greene Co. (3286).

HYOPHILA TORTULA (Schwaegr.) Hampe. Admixed with *Eucladium verticillatum* (3286) cited above. This species has been recently reported from Shannon and Carter counties in southeastern Missouri by Crum and Anderson (1958).

TORTULA RURALIS (Hedw.) Smith. Forming extensive dense cushions on exposed limestone rocks on the upper ledges of the steep bluffs above the James River just below Lake Springfield, Greene Co. (3287).

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THE BRYOPHYTES OF A DESERT REGION IN ARIZONA

JAMES A. MCCLEARY[1]

Although there have been numerous bryophyte collections from the Arizona desert, most were made incidental to other collections, and there has been no concerted effort to study any particular area thoroughly. Haring (1941, 1947) listed a number of mosses found in the lower portions of Grand Canyon below 4000 ft.;

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Clover and Jotter (1944) also made collections in Grand Canyon during their river trip; Bartram (1924, 1924a, 1924b, 1927) visited Tucson for a number of winters and was thus able to collect in that general area. The author (McCleary, 1951, 1953, 1954) has collected over much of the state but particularly in Maricopa, Gila and Pinal Counties, of which a large portion is desert. Only three reports of desert hepatics have been given: Evans (1917) recorded *Targionia hypophylla L.* and *Asterella californica* (Hampe) Underw. from the Bright Angel Trail at the bottom of Grand Canyon. Little (1939) added *Mannia californica* (Gottsche) Wheeler to this list. Austin (Wheeler, 1879) had previously reported 15 liverworts but did not give collecting data; however, the plants listed were probably not desert species.

The author (1951), in discussing altitudinal ranges of mosses, found that of the 31 species reported in Arizona as occurring regularly below 5000 ft. altitude, 21 of them belonged to the Pottiaceae, five to the Grimmiaceae, four to the Funariaceae, and one each to the Bryaceae and Fissidentaceae.

Papago Park, the area under study in this paper, is located between Tempe and Phoenix. At one time a national monument, it is now owned by the state and is not under irrigation or cultivation. However, present plans are to sell the title to the city of Phoenix so that recreation facilities such as golf courses, etc. will occupy much of it. In general it is of uneven terrain, being dissected by many small washes and arroyos. Several hills of one to two hundred feet in height rise abruptly from the desert floor which lies at an altitude of 1200 feet. The slopes are generally rather steep except on the south side where the incline is more gradual. The hills are basically of sandstone, shale and conglomerate of Cretaceous and Tertiary ages. The fill in the valleys consists of sand, gravel and conglomerate. Due to the sparseness of vegetation, little or no organic matter is found in the soil. The nature of the soil is such that water does not remain long except in small amounts in depressions following a rain. The climate of the region is severe in the summer and mild in the winter. Maximum temperatures have ranged from 119° to 12° F., but days over 110° are not common, and freezing temperatures in the winter are seldom known. The average annual temperature is around 70°, with the average of the maxima 84° and average of the minima 56°. Precipitation occurs only as rain. A primary maximum fall occurs from July 1 to September 30, and a secondary maximum comes during the winter season, mainly in December and January. Relative humidity is always comparatively low, and

percentage of maximum sunshine is high, approaching 85% of the possible time.

According to Shreve (1951), Papago Park proper would fit geographically into the Arizona Upland subdivision of the Sonoran Desert. Botanically the region which surrounds Papago Park is an ecotone between the Arizona Upland and the Lower Colorado Valley. The Arizona Upland is characterized by the presence of an open stand of microphyllous shrubs and trees and various cacti, particularly *Opuntia*. In the area covered by this study, *Larrea tridentata* (DC) Coville and *Franseria deltoides* Torr. are dominant on the more level sections with *Opuntia bigelovii* Engelm. and *Carnegia gigantea* (Engelm.) Britt. & Rose also appearing prominently. Along the lower washes and arroyos, *Cercidium microphyllum* (Torr.) Rose & Johnson, *Olneya tesota* Gray and *Prosopis juliflora* var. *velutina* (Woot.) Sarg. are common. *Encelia farinosa* Gray is abundant especially on the hillsides. Along washes and at bases of cliffs, particularly on the north-facing slopes, *Baccharis sarothroides* Gray and *Lycium fremontii* Gray occur. The early spring is characterized by the presence of many ephemerals, including *Lepidium lasiocarpum* Nutt., *Lupinus sparsiflorus* Benth., *Sphaeralcea coulteri* (Wats.) Gray, *Phacelia distans* Benth., *Amsinckia intermedia* Fisch. & Meyer and several species of *Pectocarya* and *Cryptantha*. *Plantago insularis* Eastw., together with the annual grass *Schismus barbatus* (L.) Thell., blankets the ground. In moister soil at the foot of rocks and cliffs are found such plants as *Pholistoma auritum* (Lindl.) Lilja and *Eucrypta micrantha* (Torr.) Heller.

Generally speaking, bryophytes can be collected in the Arizona Upland with much success only in the spring. At that time, due to winter rains and lower temperatures, liverworts and mosses may be found along the bottoms and sides of washes, crowded under shrubs or mixed in with prostrate plants such as *Selaginella arizonica* Maxon.

Hepaticae

Riccia dictyospora Howe is most commonly intermingled with *Selaginella arizonica* on moister slopes and in the silty bottoms of washes. In wetter springs, it can also be found in the shade of creosote bushes where its bright green color causes it to stand out against the darker background of the earth.

Targionia hypophylla L. This species is found commonly interspersed with *Selaginella arizonica*, which abounds in certain parts of Papago Park. However, both plants are restricted to north-facing slopes except where narrow passes running north and south through the summit of small hills allow full shade except at noon. In the shade, *Targionia* may occur on any slope. The presence of *Selaginella* deters the washing of soil from the hillsides and encourages an accumulation of moisture-retaining silt three to six

inches in depth. When hot weather sets in, this liverwort curls upward and becomes difficult to locate. Previous reports of this species from other parts of the state indicate its widespread presence below altitudes of 5000 ft.

MUSCI

ALOINA RIGIDA (Schultz) Lindb. This moss is confined to a xerophytic habitat. Bartram has previously collected it in the Tucson Mts., near Tucson. The Tucson Mts. reach an altitude of nearly 3000 ft. which is still within the range of strictly xerophytic vegetation. The moss is found in Papago Park under shrubs and among annual herbs and grasses where some protection from the direct rays of the sun can be obtained or in ditches where water tends to be channeled.

CROSSIDIUM ABERRANS Holz. & Bartram. Along the steep sides of gullies is an excellent situation to search for *Crossidium*. Although not abundant in Papago Park, this species has been found several times. Being small, it is undoubtedly overlooked especially during dry, sunny days when the gametophyte becomes shriveled and insignificant.

DESMATODON LATIFOLIUS (Hedw.) Brid. Although few bryophytes can be said to occur in great abundance in desert regions, *Desmatodon* would probably rank second to *Grimmia* in frequency in Papago Park. *Desmatodon* is usually found crowded close to the base of boulders or even small pebbles but directly upon soil where drainage is such that additional water is available.

DESMATODON OBTUSIFOLIUS (Schwaegr.) Jur. This moss occupies almost the same ecological niche as *D. latifolius* and could easily be mistaken for it without close scrutiny.

Tortula inermis (Brid.) Mont. Many members of the genus *Tortula* are common in the Southwest. Most of them are, however, located above 4000 ft. altitudes. *T. inermis* has been reported numerous times always below 4500 ft. In Papago Park it is certainly not very abundant but has been found in crevices of east-facing boulders.

TORTULA OBTUSSISSIMA (C. M.) Mitt. occurs as clumps on the ground in totally exposed habitats. Although not as common at lower altitudes (such as those in Papago Park) as it is above 3000 ft., it probably is the most abundant soil-inhabiting bryophyte in the entire state.

GRIMMIA PULVINATA (Hedw.) Smith. Bartram (1924) recorded the abundance of this moss on ledges of steep banks of dry washes around Tucson. It is also frequent in Papago Park on east- and north-facing boulders.

GRIMMIA WRIGHTII Aust. is found in the same habitat as *G. pulvinata* but is very scarce.

ENTOSTHODON ATTENUATUS (Dicks.) Grout, together with E. RUBIGINOSUS (Williams) Jones and RUBRISETUS (Bartr.) Grout, occurs regularly mixed with *Riccia*, *Targionia* and *Selaginella*. These species of *Entosthodon* are widespread on soil but nowhere abundant enough to form mats or otherwise be easy to locate.

FUNARIA HYGROMETRICA Hedw. and F. MUHLENBERGII Turn. At one place along the eastern boundary of Papago Park a large canal, part of the irrigation system in the Salt River Valley, crosses a low area by means of an aquaduct. This aquaduct leaks so that the ground is always moist beneath it. In such a local habitat, *F. hygrometrica* and *F. muhlenbergii* are abundant.

BRYUM ARGENTEUM Hedw. This moss can be collected at many places in the desert. It occurs on silt-covered rocks or on open soil.

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FRULLANIA SPECIES COLLECTED IN LOUISIANA BY KOCH

LOIS CLARK[1]

During the years 1954-1956, Dr. L. F. Koch made many collections of Hepaticae in the state of Louisiana. The *Frullania* species were sent to us for determination. It seems to us that the localities of these should be made known to those interested in geographic distribution.

FRULLANIA ASAGRAYANA Mont. TERREBONNE PAR., Houma, about 5 miles west along highway 90, in swamp, Oct. 16, 1954 (7534). *Known from Florida and northward.*

FRULLANIA BRITTONIAE Evans. CALDWELL PAR., 9 miles east of Columbia, Feb. 25, 1955 (9142). CLAIBORNE PAR., about 6 miles south of Homer, Aug. 10, 1954 (6010, 6019). CONCORDIA PAR., about 3 miles north of Ferriday,

[1] University of Washington, Seattle, Wash. This work was made possible by a grant from the Biological and Medical Research Fund of the State of Washington.

Jan. 23, 1955 (8049). CARROLL PAR., along highway 11, about 3.5 miles west of highway 65, Jan. 24, 1955 (9034). LINCOLN PAR., about 8 miles north of Rushton, Aug. 10, 1954 (5060, 5065). LIVINGSTON PAR., about 5 miles northwest of Black Bayou, Mar. 12, 1955 (9591). WEST FELICIANA PAR., 1 mile north of Plattenberg, Apr. 30, 1955 (10381). JACKSON PAR., Wyatt road, just east of highway 167, Aug. 10, 1956 (5121). *Known from the Gulf states and northward.*

FRULLANIA COBRENSIS Gottsche. MADISON PAR., just north of Tallulah, Jan. 24, 1955 (9015). WEST FELICIANA PAR., 1 mile south of Angola, Apr. 14, 1955 (9961). *Known also from Florida and southward.*

FRULLANIA EBORACENSIS Gottsche. BOISSIER PAR., 5 miles north of Plaindealing, Bolinger Fire Tower Hill, Apr. 8, 1955 (10187, 10197). CADDO PAR., Shreveport, bluff below Veterans' Hospital, Apr. 8, 1955 (10044). CLAIBORNE PAR., about 6 miles south of Homer, Aug. 10, 1954 (6012). CONCORDIA PAR., about 9 miles west of Ferriday, Jan. 25, 1955 (9238). EAST FELICIANA PAR., west of Thompson Creek, in woods along highway 61, Nov. 6, 1954 (7804, 7813); and northeast of St. Francisville along highway 124, in beech forest, Nov. 7, 1954 (7775). JACKSON PAR., along Wyatt road, just east of highway 167, Aug. 10, 1954 (5025). LIVINGSTON PAR., 5 miles southwest of Black Bayou, Mar. 12, 1955 (9584). MADISON PAR., just north of Tallulah, in swamp, Jan. 24, 1955 (9018, 9019, 9026). TANGIPAHOA PAR., north of Kentwood, near Terry Creek, Dec. 16, 1954 (7950). TENSAS PAR., along highway 65, 3 miles north of south border of the parish, Jan. 23, 1955 (8078). WEST FELICIANA PAR., 1 mile south of Angola, Apr. 14, 1955 (9997). *Reported from Florida, Texas and northward but not from the Caribbean region.*

FRULLANIA INFLATA Gottsche. ACADIA PAR., about 2 miles east of Crowley, Oct. 17, 1954 (7640, 7640-1). BIENVILLE PAR., summit of Driskill Mountain, Aug. 11, 1954 (6063, 6088). CADDO PAR., just north of Shreveport, in woods, Apr. 14, 1955 (10051) CALDWELL PAR., 9 miles east of Columbia, Feb. 25, 1955 (9145), with *F. obcordata.* DESOTO PAR., along highway 147 toward Longstreet, 6 miles west of highway 171, Apr. 6, 1955 (10139). EAST CARROLL PAR., along highway 11, 3.5 miles east of highway 65, Jan. 24, 1955 (9041). EAST FELICIANA PAR., northeast of St. Francisville, Nov. 7, 1954 (7797). JEFFERSON PAR., along highway 30 about 3 miles south of the Mississippi River, Nov. 11, 1954 (7843), with *Euosmolejeunea duriuscula;* also north side of Grand Isle, east of Rigaud Lane, Apr. 5, 1955 (10063). LASALLE PAR., about 9 miles west of Ferriday along highway 84, Jan. 25, 1955 (9242). LINCOLN PAR., about 7 miles north of Rushton and about 1 mile east of highway 167, Aug. 10, 1954 (5091). MOREHOUSE PAR., along Bayou Little Bonne Idee, Jan. 24, 1955 (9057). NATCHITOCHES PAR., Nat. Red Dirt Game Management Preserve, below Lotus-Gorum Road, Mar. 17, 1955 (9780), also about 2 miles southwest of Gorum (9855). PLAQUEMINES PAR., along highway 30, about 10 miles south of the Mississippi River, Nov. 11, 1954 (7889). ST. JOHN THE BAPTIST PAR., along Lake Pontchartrain, in Frenier Swamp, Feb. 27, 1955 (9355), with *F. obcordata.* TENSAS PAR., 3 miles north of the southern parish border, along highway 65, Jan. 23, 1955 (8097). WEST FELICIANA PAR., along highway 61, near Bains, Apr. 30, 1955 (10396). *Reported from the Gulf States and Mexico but not from the Caribbean region.*

FRULLANIA KUNZEI Lehm. & Lindenb. CALCASIEU PAR., along highway 90, about 6 miles east of state line, Oct. 17, 1954 (7594). GRANT PAR., along highway 167, 1 mile south of parish boundary, Aug. 11, 1954 (7020). JEFFERSON PAR., along highway 30, about 3 miles south of the Mississippi

River, Nov. 11, 1954 (7879); and Grand Isle, northeast corner, Apr. 5, 1955 (10089). LaSalle Par., along highway 6, about 12 miles east of highway 165, Jan. 24, 1955 (9196), with *F. squarrosa* Livingston Par., along highway 160, about 5 miles northeast of highway 54, in swamp along Black Bayou, Mar. 12, 1955 (9546). St. Bernard Par., along highway 32 west of Reggio, in woods, Feb. 22, 1955 (9286). St. John the Baptist Par., in swamp near Lake Frenier, Aug. 8, 1954 (7075), and near Frenier (7093), also near Lake Pontchartrain, Frenier (7082). St. Tammany Par., Fontainebleau State Park, Mar. 6, 1955 (9414). Terrebonne Par., Houma, 5 miles west along highway 90, Oct. 16, 1954 (7527); also 6 miles north of Cocodrie, opposite Little Cocodrie Packing Company, east bank of Bayou La Fourche, May 15, 1955 (10475, 10475-1, 10475-2). Washington Par., about 10 miles north of Franklinton along highway 34, Sept. 30, 1954 (7401); also 7 miles northeast of Varnadow, along Pearl River, Mar. 10, 1955 (9531). West Feliciana Par., 1 mile south of Angola, Apr. 14, 1955 (9980); and near Bains, Apr. 30, 1955 (10394). *Reported from the Gulf States and northward, and from Puerto Rico.*

Frullania obcordata Lehm. & Lindenb. Caldwell Par., 9 miles east of Columbia, near Clark Road, Feb. 25, 1955, among *F. inflata* (9145). St. John the Baptist Par., along Lake Pontchartrain, in Frenier Swamp, Feb. 27, 1955 (9345, 9370), and among *F. inflata* (9355). Jefferson Par., in swamp around Wiggaman Pond, Mar. 24, 1955 (9924a). *Reported from both northward and southward of southern boundary of the United States.*

Frullania squarrosa (R., Bl. & N.) Dum. Calcasieu Par., about 6 miles east of state line, near highway 90, Oct. 17, 1954 (7598, 7598-1). East Feliciana Par., northeast of St. Francisville, Tunica Hills, Nov. 6, 1954 (7696, 7769), and west of Thompson Creek, near highway 61 (7826). Grant Par., along highway 167 about 1 mile south of north boundary of parish, Aug. 11, 1954 (7020-1, 7049). Jackson Par., along Wyatt road just east of highway 167, Aug. 10, 1954 (5014). Jefferson Davis Par., near highway 90 about 32 miles east of west boundary of parish, Oct. 17, 1954 (7631). LaSalle Par., along highway 6, 12 miles east of highway 165, Jan. 24, 1955, among *F. kunzei* (9196). Livingston Par., about 5 miles east of Black Bayou, Mar. 12, 1955 (9579). Natchitoches Par., 2 miles southwest of Gorum, Mar. 17, 1955 (9875); also south of Natchitoches along bank of Red River, Mar. 19, 1955 (1917). St. John the Baptist Par., near Lake Pontchartrain, at Frenier, Aug. 8, 1954 (7083). St. Tammany Par., along highway 190, 1 mile west of Fountainebleu State Park, Apr. 24, 1955 (10033). West Feliciana Par., 1 mile south of Angola, Apr. 14, 1955, also 1 mile north (9985). *Ranging far north and far south of the southern border of the United States.*

It is surprising how few of the species of *Frullania* of the Caribbean region are found in the United States and also that not more of those species reported in the states bordering the Gulf of Mexico have been found in the Caribbean region. The most northern of the Bahamas are approximately 150 miles farther north than the most southern islands of Florida. Cuba itself is less than 100 miles from Key West. Wind-borne spores surely would be carried across the separating waters.

Temperature does not seem to account for so definite a range limit, for southern Florida must be very similar to some of the

more elevated regions of Cuba and much like parts of the Bahamas. Perhaps a bigger factor is the few collections yet made in the Bermudas and along the shores of the Gulf of Mexico. There is the physical difficulty of collecting in swampy regions and the financial difficulty of visiting many distant islands. The following species not included in this paper are reported to occur in Louisiana: *F. cobrensis*, *F. cucullata* and *F. gymnotis*, all of which are more southern in range and merely breaking over the southern boundary into the United States.

THE LICHEN COLLECTION OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

W. L. Dix[1]

The herbarium of The Academy of Natural Sciences of Philadelphia is one of the oldest in North America. The foundation of the lichen herbarium was laid by Nicholas S. Parmentier's contribution in 1812 of some 85 specimens, with very scanty data, either "Europe" only, or occasionally with the addition of "au Montanverde." There are three or four specimens signed "Ach." The labels bear no evidence of whether Acharius was the collector or merely the annotator. In 1834 the Rev. Lewis David von Schweinitz presented to the Academy his collection of 750 specimens. In 1897 Gotthilf Muhlenberg's collection belonging to the American Philosophical Society was deposited in the Academy herbarium. Edward Tuckerman gave to the Academy Fascicles I-VI of his collections.

The following is a list of the more important collections now in the Academy herbarium, with the approximate number of specimens and their geographic origin:

Foreign

Arnold, Ferdinand (Germany)..157
Bang, Miguel (Bolivia)..... 66
Blomberg, O. G. (Scandinavia)..398
Bornemüller, Jos. (Madeira).... 66
Bailey, Edward (Hawaii).....269
Fries, T. (Sweden)..... 6
Glaziou, August (South America) 29
Hegetschweiler, Johann (Switzerland) 55
Heller, A. A. (Hawaii)..... 92
Indebetou, Conrad (Scandinavia) 54
Loika, H. (Hungary).....254
Maughan, R. (Scotland).....109
Morong, Thomas (South America) 45
Oldfield, E. (Australia)..... 53
Parmentier, Nicholas S. (see above) 85
Puiggari, Juan (Brazil)..... 35
Rusby, H. H. (South America).. 38
Shirley, John (Australia).....122
Wright, Charles (Cuba, Japan)..106
Zetterstedt, J. E. (Austria)..... 32

[1] The Academy of Natural Sciences, Philadelphia, Pa.

NORTH AMERICAN

Bolander, H. (California)..... 37
Calkins, W. W. (Florida).....200
Cummings, Clara (United States, *Second Decades*, mostly) 147
Commons, Alexander (Delaware) 611
Darlington, Wm. (Pennsylvania) 30
Eckfeldt, J. W. (Pennsylvania) 468
Fink, Bruce (Iowa)..... 26
Green, H. A. (United States)...360
Ellis, J. B. (New Jersey)..... 72
Haase, H. E. (California)..... 67
Hall, Elihu (Oregon)..... 19
Herbst, W. (United States).... 86
Howell, Thomas (Oregon)..... 46
Lea, T. C. (Ohio).....156
Langlois, A. B. (Louisiana).....300
Lehnert, H. (Washington)..... 62
Leiberg, J. B. (Idaho)..... 75
Macoun, John (Canada).....454
Meehan, Thomas (Alaska, Canada) 43
Muhlenberg, Gotthilf (United States mostly) 350
Nuttall, Thomas (United States) 37
Pringle, Cyrus (Mexico).....202
Ravenel, H. W. (South Carolina, Georgia) 133
Tuckerman, Edward (New England, in addition to Fascicles) 47
Waghorne, A. C. (Laborador)..542
Willey, Henry (New England).. 34
Williams, T. A. (United States) 68

BRYOCEUTHOSPORA NOM. NOV.

HOWARD CRUM[1] and LEWIS E. ANDERSON[2]

Bryoceuthospora Crum & Anderson, nom. nov. (for *Ceuthospora* Crum & Anderson, Jour. Elisha Mitchell Sci. Soc. 74: 31. 1958, not *Ceuthospora* Fries, Syst. Orb. Veg. 1825, *emend.* Grev., Scot. Crypt. Flora 5: 253. 1827.)

The name *Ceuthospora* was pre-empted by Fries considerably more than a hundred years ago, a fact that inexcusably escaped our attention when we attempted to apply the name to a moss. The fungus genus *Ceuthospora* includes nearly two dozen described species, widely distributed throughout most of the world, and belongs to the order, Sphaeropsidales.

Bryoceuthospora mexicana (Bartr.) n. comb. [*Ephemerum mexicanum* Bartr., THE BRYOLOGIST 28: 66. *Fig.* 14-27. 1925; *Ceuthospora mexicana* (Bartr.) Crum & Anderson, *op. cit.*]

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[2] Dept. of Botany, Duke University, Durham, N. C.

THE 1958 FORAY OF THE AMERICAN BRYOLOGICAL SOCIETY

HARVEY A. MILLER and JOHN W. THOMSON[1]

The 1958 Foray of the American Bryological Society was held in the vicinity of Greencastle, Indiana, under the guidance of Winona H. Welch. In all, 22 persons attended the Foray which was held August 23 and 24, prior to the American Institute of Biological Sciences meetings at Bloomington, Indiana.

An informal organization period and social hour was held the evening of August 22 in Harrison Hall at DePauw University. Highlights of the evening included pictures of the Hattori Botanical Laboratory and Japanese bryologists. The pictures were collected by Dr. Paul Redfearn during a visit to Japan. Dr. Welch then presented a brief history of bryology in Indiana and showed portrait slides of many of the botanists who figured in the historical sketch. This was followed by a tour of the Department of Botany and Bacteriology and a display of historically significant books on bryology and lichenology. The meeting was adjourned with refreshments.

The next morning the participants breakfasted together and then proceeded to Fern Cliff, Lucien M. Underwood's famous collecting site in Putnam County. On exposed clay soil near the parking area, *Mannia fragrans*, *Phaeoceros laevis* and a sterile *Fossombronia* were growing in mixture with *Bryum argenteum* and *Weissia viridula*. A short walk led to a second-growth deciduous woodland where *Platygyrium repens*, *Rhynchostegium serrulatum*, *Atrichum angustatum*, *Entodon seductrix*, *Anomodon attenuatus* and *Frullania eboracensis* were abundant. The cliffs themselves, composed of Mansfield sandstone, appeared to be constantly moist and were covered with an almost continuous mat of bryophytes. Areas several square yards in extent were covered with a mosaic of *Scapania nemorosa* and *Plagiochila asplenioides* interwoven with *Mnium punctatum*, *Mnium affine* and other mosses. *Fissidens osmundioides* and *F. minutulus* were abundant on the walls, as were *Pellia epiphylla*, *Conocephalum conicum*, *Reboulia hemisphaerica* and *Porotrichum alleghaniense*. On soil at the base of the cliff we observed *Campylium chrysophyllum*, *Leucobryum glaucum*, *Plagiothecium denticulatum* and *Fissidens taxifolius*.

At Fern Cliff an old open field with scattered stands of sassa-

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FIG. 1. The Foray group at Fern Cliff, Putnam County, Indiana. *Left to right:* Paul Redfearn, Clarence H. Hand, Mrs. Hand, Lewis E. Anderson, Harvey A. Miller, Richard D. Houk, Winona H. Welch, Walter Ainsworth, Paul Biebel, Sam Shushan, and John W. Thomson. Also on the foray but not in the photograph were H. H. Holliger, Mrs. Holliger, John Holliger, Steffann Holliger, and Arthur Cridland. Additional participants in the evening programs included T. G. Yuncker, Mrs. Yuncker, C. L. Biebel, Mrs. Biebel, Ella Hixson, and Ruth Breen.

fras yielded a number of interesting lichens, especially where digging had left edges along the sod where Cladonias were quite abundant. Here were collected *Cladonia robbinsii*, *C. subcariosa*, *C. verticillata*, *C. chlorophaea*, *C. piedmontensis* fo. *lepidifera* and *C. subtenuis*. On the lower, dead branches of the sassafras was some *Bacidia chlorococca*. The elms around the clearing had *Physcia stellaris* and *Candelaria concolor* in abundance. *Allarthonia caesia* was in its commonest habitat, on the bark of old hickory. A maple in the open in the field had a few thalli of *Parmelia dubia* on the bark near the base, and a white ash near the place were the cars were parked had an abundance of *Physcia*, including *P. orbicularis*, *P. millegrana*, and *P. stellaris*. On the way down to the base of the cliff several boulders supported colonies of *Lecidea albocaerulescens*, *Peltigera evansiana*, and *Peltigera canina* var. *rufescens*.

From Fern Cliff, the groups drove roughly along the drift line between the Illinoian and Wisconsin glaciation to Parke County

and Fallen Rock. An easy walk from Fallen Rock brought them to Dr. Welch's "Sword Moss Gorge" where *Bryoxiphium* occurs in quantity over a large expanse of one wall of the small gorge cut into Mansfield sandstone. Extensive mats of *Scapania nemorosa* were punctuated with mature capsules of *Diphyscium foliosum* and isolated plants of *Atrichum macmillani*. Small carpets of *Mnium punctatum* and *Aulacomnium heterostichum* covered parts of the stone walls which supported open stands of *Fissidens minutulus* and *F. ravenelii* mixed somewhat with the sword moss. *Jungermannia lanceolata* and *Solenostoma crenuliformis* were collected with mature perianths elsewhere within the gorge. It was necessary to climb the smooth, steep face of a small waterfall to reach the upper part of the gorge, but except for one bryologist who slid down without losing his hat, it was negotiated without incident. The wooded bluff above the waterfall overlooking the gorge was carpeted with *Polytrichum ohioense, Leucobryum glaucum, Dicranum scoparium, Atrichum undulatum, Hypnum lindbergii* and, on the bases of trees, *Leskea gracilescens*. Mature sporophytes of *Jamesoniella autumnalis* were collected growing over *Leucobryum*.

At Fallen Rock the lichenologists collected *Cladonia cristatella* and *C. clavulifera* on mosses. *Lecidea cyrtidia* was found on the exposed sandstone, but in deep shade the rock was covered in places by a deep green thallus with a somewhat "greasy" look and with scattered pink apothecia on an exceedingly short stipe. It had the appearance of *Bacomyces* and was later confirmed as the most remarkable find of the foray, *Bacomyces absolutus*. This is a tropical species reported in Fink's *Lichen Flora of the United States* from North Carolina, Florida and Alabama so that this is an astonishing extension of range. This same species was also found on the following day at Hoosier Highlands so that it must be fairly common in the region.

On an old concrete bridge abutment were a *Catillaria* close to *C. chalybeia, Placynthium nigrum* and *Caloplaca flavovirescens*.

In Sword Moss Gorge *Lecidea virginiensis* and *Peltigera canina* var. *rufescens* fo. *innovans* were collected. Higher on the walls along the upper path were *Cladonia squamosa* and *C. furcata* var. *pinnata* fo. *foliolosa*. On some sandstone rocks in the path were *Psorotichia schaereri* and more *Lecidea virginiensis*. As the lichen collectors crossed over the ridge back to the road, they inspected the white oaks and collected a number of species including *Anaptychia palmatula, Cladonia clavulifera* at the base of an oak, *Leptogium cyanescens, Parmelia aurulenta, Physcia tribacoides* and a squamulose form of *Physcia ciliata*. A large boulder

was vigorously attacked with hammer and chisel by the lichenologists for thalli of *Rhizocarpon concentricum*.

The final stop of the day was at Vermilion Falls, a site of an exposure of St. Louis limestone in Putnam County. The valley along the creek was a rather open young second growth woodland on rocky soil. The only hepatics found were *Porella platyphylloidea* and *Frullania eboracensis* on trees with the former sometimes occurring on rocks. *Platygyrium repens*, *Leskea gracilescens* and *Anomodon attenuatus* were the most abundant corticolous mosses. Exposed rocks were capped with patches of *Grimmia* and *Hyophila tortula*.

Dripping limestone walls were covered with irregular knobs of *Gymnostomum aeruginosum* and clumps of *Eucladium verticillatum* were discovered for the first time in Indiana in a wet cave-like depression under the falls. At the top of the falls the solid limestone bed of the creek was exposed to full sun for much of the day but *Mniobryum wahlenbergii* and *Philonotis marchica* grew intermixed on wetted rock in the creek bed. In the water itself a few plants of *Fissidens debilis* were pointed out by Dr. Welch, as well as an abundance of *Leptodictyum riparium*.

Characteristic lichens of limestone were in abundance at Vermilion Falls. The thalli of *Dermatocarpon miniatum* were very large and covered the rocks by the falls. Among the other species on the limestone were *Verrucaria calciseda*, *Caloplaca flavovirescens*, *Placynthium nigrum*, *Caloplaca citrina*, *C. lactea*, *Lecania perproxima*, *Lecidea erratica* and *Physcia orbicularis*. On soil just over the limestone outcrop in the open sunlight were *Dermatocarpon hepaticum*, *Leptogium lichenoides* and *Cladonia capitata* fo. *microcarpa*. The ash trees around the falls added *Graphis scripta*, *Parmelia rudecta* and *Pyxine sorediata* to the list of species collected. On the way back to Greencastle at the close of the day's collecting, the lichenologists stopped at a roadside stump to gather excellent fruiting material of *Xanthoria fallax*.

After the day in the field, the group assembled for dinner at a special table in the DePauw Union, where hearty appetites were well satisfied. Following dinner, the group was treated to a special program by Dr. T. G. Yuncker, who presented a most stimulating and well illustrated talk about his recent trip to Jamaica on the trail of *Peperomia*. The herbarium was opened after a round of refreshments and preliminary evaluation of some of the day's collections lasted until after midnight.

The next morning the group departed for Hoosier Highlands in Putnam County. This is an area of relatively mature and undisturbed deciduous forest and considerable relief. The morning

trip followed a creek bed which exposed Ste. Genevieve limestone overlaid by a clay forest soil. *Hygroamblystegium tenax* was abundant in the creek bed itself while the soil banks supported *Fissidens taxifolius, Thuidium delicatulum, Cirriphyllum boscii* and *Atrichum angustatum* intertwined by *Mnium medium*. Noteworthy corticolous species found were *Forsstroemia trichomitria, Schwetschkeopsis denticulata* and *Haplohymenium triste*. *Frullania riparia* was discovered on the exposed limestone. Along the way *Leptogium cyanescens, Parmelia aurulenta* and *Anaptychia speciosa* were collected on a sycamore. A red maple added *Pyxine sorediata* and an ash beside the stream had the *Pyxine, Parmelia dubia, P. caperata* and a single thallus of *Ramalina fastigiata* growing on it. At the falls in the brook we found *Verrucaria iowensis* and a *Catillaria*, close to *C. chalybeia*.

Leaving the bryologists at work in the moist area near the stream, the lichenologists climbed the slopes through a dry oak woods. On the bark of these trees, mainly near the base, were *Bacidia schweinitzii, Graphis scripta, Pertusaria copiosa, Cladonia bacillaris* fo. *clavata* and *C. clavulifera*. Toward the top of the ridge the soil was richly covered with lichens, especially *Cladonia capitata* fo. *imbricatula*. Other species in the lichen mat were *Cladonia cristatella* fo. *beauvoisii* and fo. *squamosissima, C. caespiticia, C. delicata, C. furcata* var. *pinnata, C. grayi* fo. *carpophora, C. cylindrica* fo. *squamulosa, C. verticillata* fo. *evoluta, Peltigera canina* var. *rufescens* and *Poroscyphus furfurellus*. On pebbles in the lichen mat in the oak woods *Lecidea cyrtidia* was found.

During the afternoon the group visited the Mansfield sandstone area within easy walking distance from the previous collecting spot. This small area boasted considerable relief and was extremely rich in species. *Pogonatum pensilvanicum* and *Mannia rupestris* as well as fruiting *Thuidium delicatulum* were collected on exposed clay soil along the road into the area. One of the first interesting discoveries was *Hedwigia ciliata* on the top of a 15-foot boulder scaled by Dr. Redfearn. Sides of the boulder were covered with a rich mat of *Lophocolea heterophylla, Cladonia coniocraea* fo. *ceratodes, Leptogium lichenoides* and *Lecidea albocaerulescens*. Other hepatics found on exposed rock surfaces of the sandstone bluffs were *Scapania nemorosa* and *Diplophyllum apiculatum*. On one such bluff a quantity of *Brothera leana* was discovered and all who wished samples were able to get them. Nearby, as well as on other ledges, was more of the lichen rarity *Bacomyces absolutus*.

Having explored the hillsides and the top, the more hardy descended the steep slopes into a gorge about 100 feet deep. In

many ways this gorge resembled the areas visited at Fern Cliff and Sword Moss Gorge, but the trip was made worthwhile by the discovery by Lewis Anderson of numerous small colonies of *Hookeria acutifolia*. Hepatics collected only in this area included *Jubula pennsylvanica* and *Cephaloziella rubella*.

It is almost impossible to discuss every species found in each of the habitats visited, and so the senior author has prepared a list of bryophytes found on the foray. Most of the species listed were collected by the senior author, with others generously contributed by Dr. Redfearn, Mr. Houk and Dr. Welch. Dr. Lewis Anderson of Duke University made most of the moss determinations, and Mr. Yukinobu Kuwahara of Miami University studied many of the hepatics. Lichen determinations were handled by the junior author who made all collections reported. Specimens of the listed bryophytes are deposited in the DePauw Herbarium, and a nearly complete set is in the Miami University Herbarium. Lichens are deposited in the University of Wisconsin Herbarium.

During the early afternoon members of the foray disbanded to make their way to the meetings at Bloomington. Under the able and gracious leadership of Dr. Welch, they had gained an appreciation of an interesting and unexpectedly rich collecting area in the Midwest.

List of Bryophytes Collected

Following the species names we have designated each of the collecting areas as follows: F, Fern Cliff; S, Sword Moss Gorge; Fr, Fallen Rock; V, Vermilion Falls; Hl, Hoosier Highlands limestone area; Hs, Hoosier Highlands sandstone area. Unless otherwise indicated the collection was made by the senior author. Several species of mosses believed to be new to Indiana pending further investigation are indicated by an asterisk (*).

Mosses

Amblystegiella confervoides Hl
Amblystegium varium V, Hl
Anomodon attenuatus V
Anomodon minor Hl
Anomodon rostratus Hl (Redfearn & Houk)
Astomum ?muhlenbergianum V
Atrichum angustatum Hl
**Atrichum crispum* F
**Atrichum macmillani* S
Atrichum undulatum S, H (Redfearn & Houk, Welch)
Aulacomnium heterostichum, F, S, Hs
Barbula fallax Hl
Barbula unguiculata V
Bartramia pomiformis V (Welch)
Brachythecium flagellare F
Brachythecium oxycladon Hl
Brachythecium rivulare Hl
Brachythecium rutabulum F
**Brothera leana* Hs
Bryhnia graminicolor Hs
Bryhnia novae-angliae Hs
Bryoxiphium norvegicum F, Fr (Redfearn & Houk), S
Bryum argenteum V
Bryum caespiticium F, V
Bryum pseudotriquetrum S, V (Redfearn & Houk), Hl
Campylium chrysophyllum F (Redfearn & Houk)
Campylium hispidulum H (Welch)
Cirriphyllum boscii Hl
Clasmatodon parvulus Hl, Hs
Climacium americanum Hl

Desmatodon obtusifolius V (Welch)
Dicranella heteromalla S, Hl
Dicranum fulvum S, Hs
Dicranum montanum H (Redfearn & Houk)
Dicranum scoparium S, H (Redfearn & Houk)
Diphyscium foliosum S
**Ditrichum lineare* Hs
Ditrichum pallidum H (Redfearn & Houk)
Entodon cladorrhizans V (Welch)
Entodon seductrix V
Eurhynchium hians H (Welch)
**Eucladium verticillatum* V
Fissidens bryoides V
Fissidens debilis V
Fissidens minutulus F, S, V, H
Fissidens osmundioides F
Fissidens ravenelii S, V & H (Redfearn & Houk)
Fissidens subbasilaris Hl (Redfearn & Houk)
Fissidens taxifolius F, Hl
Forsstroemia trichomitria Hl
**Grimmia alpicola* V, Hl
Grimmia apocarpa V (Redfearn & Houk)
Gymnostomum aeruginosum V
Haplohymenium triste Hl
Hedwigia ciliata Hs
Homomallium adnatum Hl
Hookeria acutifolia Hs
Hygroamblystegium orthocladon V
Hygroamblystegium tenax V, Hl
Hyophila tortula V, Hl
Hypnum curvifolium H (Redfearn & Houk)
Hypnum imponens S
Hypnum lindbergii V, Hl
Leptodictyum riparium V
Leskea gracilescens V
Leucobryum glaucum F, S, Hs
Mniobryum wahlenbergii V
Mnium affine F, S, Hs
Mnium cuspidatum F, S, Hs
Mnium medium Hl
Mnium punctatum F, S, V, Hs
Mnium serratum F (Welch), S
Orthotrichum stellatum Hl
Philonotis marchica V
Plagiothecium denticulatum Hs, F (Redfearn & Houk)
Plagiothecium muellerianum H (Welch)
Plagiothecium roseum S, V
Plagiothecium sylvaticum Hs
Platygyrium repens Hl
Pohlia nutans Hs
Pogonatum pensilvanicum Hs
Polytrichum ohioense S, Hl
Porotrichum alleghaniense F
Rhodobryum roseum H (Redfearn & Houk)
Rhynchostegium serrulatum F
**Schigeria calcarea* Hl (Redfearn & Houk)
Sematophyllum carolinianum F, Hl, Hs
Schwetschkeopsis denticulata Hl
Taxiphyllum deplanatum Hl
Taxiphyllum geophilum V
Tetraphis pellucida F, S, V, Hl, Hs
Thuidium delicatulum Hl, Hs
Tortella humilis Hs
Weissia viridula S, V (Welch)

LIVERWORTS

Cephalozia media F, S, Hs
Cephaloziella rubella Hs
Conocephalum conicum F, S, Hs
Diplophyllum apiculatum S, Hs
Fossombronia ?foveolata F
Frullania eboracensis F, Hl
Frullania riparia Hl
Geocalyx graveolens S
Harpanthus scutatus F, S
Jamesoniella autumnalis S, Hs
Jungermannia lanceolata S, V, Hl
Jubula pennsylvanica Hs
Lophocolea minor F
Lophocolea heterophylla Hl, Hs
Mannia fragrans F
Mannia rupestris Hs
Metzgeria (immature) Hs
Pedinophyllum interruptum Hs
Pellia epiphylla F, S, Hs
Phaeoceros laevis F, S, V
Plagiochila asplenioides F, S, Hs
Porella platyphylla H (Redfearn & Houk)
Porella platyphylloidea V, Hl
Ptilidium pulcherrimum H (Redfearn & Houk)
Reboulia hemisphaerica F, Hs
Scapania nemorosa F, S, Hs
Solenostoma crenuliformis F, S, Hs

REVIEWS

Keissler, Karl von: "Usneaceae." Dr. L. Rabenhorst's *Kryptogamen-Flora von Deutschland, Österreich und der Schweiz.* IX. Band, 5. Abteilung, 4. Teil, Lieferung 1. 160 pp. Fig. A-C + 1-28. Akademische Verlagsgesellschaft Geest & Portig K.-G., Leipzig. 1958. Price: DM. 25.50.—Many troubled years have passed since the appearance of an installment in the lichenological section of Rabenhorst's *Krytpogamen-Flora.* Now the series resumes with the first of a projected four-part treatment of the Usneaceae. Everything remains the same: the same good format and printing, the same long literary and exsiccat citations, the same elaborate descriptions (only 16 species in the 160 pages!), the same high scholarship, the same high price. This issue treats *Evernia, Letharia* and *Alectoria,* leaving the more controversial genera for future consideration, and modifications in the nomenclature involve only four infraspecific taxa. Although the present study had no major taxonomic problems to solve, it unites and evaluates the reports of a scattered literature and, especially in those many libraries where the "Rabenhorst" is the sole major cryptogamic reference, will fill a real need. Typically the Rabenhorst issue ends arbitrarily—"Primäre Äste aufrecht oder auf- . . ."—and, so left, we can only anticipate the outcome of the sentence and of the three *Lieferungen* to follow. But the revival of this honored series could hardly be more welcome. The "Rabenhorst" is more than a mere regional flora, it is a beautiful symbol of the continuity of effort of European students of the cryptogams.—W. L. Culberson.

Barkman, J. J. *Phytosociology and Ecology of Cryptogamic Epiphytes, including a taxonomic survey and description of their vegetation units in Europe.* With a separate booklet containing association tables [*Tab.* 27-30, 33, 36-71]. pp. xiii + 628, *fig.* 1-21, *maps* 1-50, *graphs* 1-4, *photo.* 1-16, *tab.* 1-71. Cloth. Koninklijke van Gorcum & Co., N. V. Assen, Netherlands. 1958. Price: Hfl: 44.00 (ca. $11.00).—This is a very scholarly treatment of the environmental ecology and phytosociology of cryptogamic epiphytes of Europe, particularly the Netherlands. The first half of the book is an extended essay on the ecology of epiphytes. It is an exhaustive review of the literature, but it is much more than a compilation, as it is enriched and made meaningful at every point by the author's experience, insight and critical judgment. The second half is devoted to the taxonomy of 57 cryptogamic epiphytic associations arranged in orders and alliances, in the Zürich-Montpellier tradition. Each association is described as to composition, ecology, distribution, succession, etc. Pertinent and useful information on nomenclature, synonymy, and illustrations in the literature are also included here.

This is an invaluable source book of esoteric information for ecologists. But it is more than that. Having a built-in aversion to graphs, tables, and mathematical formulae, and no great desire to comprehend such terms as "Physcietum elaeinae buelliosum canescentis," I approached this book with firm resolve, but little enthusiasm. I was fascinated by it! I expect to read and re-read it, and to use it. It is full of interesting and useful information on where things grow and why. Even in browsing through the book, I easily gained insight into many ecological problems which I had observed and wondered about in the course of my own collecting activities, but was unable to explain.

I recommend this book very highly to ecologists and also to any bryologist or lichenologist whose interest in collecting goes beyond the mere acquisition of specimens.—Howard Crum.

NYHOLM, ELSA. *Illustrated Moss Flora of Fennoscandia. II. Musci.* Fasc. 3, pp. 189-288, *fig.* 94-163. C. W. K. Gleerup. Lund, Sweden. 1958. Price: 15 Swedish crowns (ca. $2.70).—The third instalment of this admirable work was no doubt the most difficult to prepare and will be the most useful one to North American bryologists because of its critical treatment of the genus *Bryum*. Nearly all the American species of *Bryum* occur also in Fennoscandia. Dr. Nyholm has divided a number of them into segregates but, as one would expect in such a nasty genus, not always with complete success. For example, *Bryum salinum* is given independence, with considerable justification, but it appears to be so variable that it has no particular character of its own and no obvious virtue as a segregate beyond the fact that it *does* tidy up what is left of *B. archangelicum!* As one would expect, the key to the species of *Bryum* does not always work smoothly for American material, but it is a great help when used in conjunction with Andrews' key in Grout's *Moss Flora*. The stylistic uniformity of the illustrations makes it possible to compare more successfully than ever before the small and intangible features which add up to specific differences in *Bryum*.

In addition to the Bryaceae, this fascicle includes the Mniaceae, Aulacomniaceae, and Meesiaceae. It is interesting to note that *Mnium hymenophyllum* and *M. hymenophylloides* are referred to *Cyrtomnium*, following Holmen's recent discovery of the distinctive fruits of *M. hymenophyllum*.

After using this and the two preceding fascicles a great deal I find much to admire and commend. I also find the illustrations too much reduced and the descriptions too much truncated. The result is that recourse to other works is too frequently necessary.—HOWARD CRUM.

RECENT LITERATURE ON MOSSES

MARGARET FULFORD[1]

ALLORGE, VALIA & CRUZ CASAS DE PUIG. Contribution à la flore bryologique de l'Espagne. Rev. Bryol. et Lichén. 27 (1/2): 55-65. 1958. [55 mosses, 19 hepatics]

ANDERSON, L. E. The mosses of North Carolina. VII.—Addenda and corrections. THE BRYOLOGIST 61(3): 204-213. 1958.

BIRSE, EVELYN. Ecological studies on growth-form in bryophytes. III. The relationship between the growth-form of mosses and groundwater supply. Jour. Ecol. 46(1): 29-42. 1958.

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BUEN, H. *Sphagnum Lindbergii* in Norway. Nytt Mag. 6: 129-134. 2 *fig.* 1958.

BÜNNING, E. & H. ETZOLD. Über die Wirkung von polarisiertem Licht auf keimende Sporen von Pilzen, Moosen und Farnen. Ber. Deutsch. Bot. Gesell. 71(7): 304-306. 3 *fig.* 1958. [Including experiments on *Funaria hygrometrica*]

CASAS DE PUIG, CRUZ. Algunas briófitas del Macizo de Garraf. Collectanea Bot. 3(1[3]): 69-75. 1951.

———. Una excursión bryologica al valle de Nuria. *Ibid.* 3(2[8]): 199-206. 1952. [21 hepatics, 78 mosses]

———. Aportaciones a la brioflora catalana. Excursiones bryológicas por el Alto Berguedá. *Ibid.* 4(1[8]): 141-159. 1 *map.* 1954

CHRISTENSEN, G. K. ET AL. The distribution of the bryophytes in Denmark. Bot. Tidsskr. 50: 92-102. 1953. [Danish]

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CLIFFORD, H. T. Victorian Musci. I. Introduction and Andreaeaceae. Roy. Soc. Victoria, Proc. 64(1): 4-9. 4 *fig.* 1952.

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CORTÉS, L. C. Aportaciones a la briologia española. (Un musgo nuevo la flora des Guadarrama.) Anales Inst. Bot. A. J. Cavanilles 13: 129-134. 1 *fig.* 1954 (1955) [New: *Mnium affine elatum* (BSG) Cortés comb. nov.]

———. Aportaciones a la briologia española. *Ibid.* 13: 533-549. 1954 flora española.) *Ibid.* 13: 135-147. 5 *fig.* 1954 (1955). [New: *Bryum Muehlenbeckii* v. *obtusifolium* n. v., *Trichostomum viridulum* v. *unguiculatum* (Philib. ex Schimp.) n. v.]

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———. Aportaciones a la briologia española. [La *Tortula guepini* (Br. eur.) Limpr., musgo nuevo para la flora española.] *Ibid.* 14: 170-178. 3 *fig.* 1955.

[1] Dept. of Biological Sciences, University of Cincinnati, Cincinnati 21, Ohio.

———. Aportaciones a la briologia española. Nota sobre algunos musgos y liquenes de El Escorial. *Ibid.* 14: 179-186. 1955.

CRUNDWELL, A. C. Some bryophytes from the Dingle Peninsula. Irish Nat. Jour. 10: 309-311. 1952.

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FITZGERALD, R. D. Some Irish moss records. Irish Nat. Jour. 10(4): 108. 1950.

———. Some Irish moss records. III. *Ibid.* 10(12): 320. 1952.

FROEHLICH, J. Die von Prof. F. Ruttner 1928/29 auf Bali, Java unc Sumatra gesammelten Musci. Arch. f. Hydrobiol. Suppl. 21(3/4): 299-342. 1955. [New: *Andreaea javanica* n. sp., *Fissidens gedehensis* v. *laxuensis* J. Baumg. & Froehl. n. v., *Anisothecium Ruttneri* n. sp., *Campylopus perinvolutus* Thér. n. sp., *C. Ruttneri* Thér. n. sp., *Rhabdoweisia fugax* v. *collenchymatica* n. v., *Syrrhopodon cataractarum* n. sp., *Mercya repandula* J. Baumg. & Froehl. n. sp., *Hymenostylium collenchymaticum* J. Baumg. & Froehl. n. sp., *Hyophila elliptica* J. Baumg. & Froehl. n. sp., *Barbula sumatrana* v. *singkarakensis* J. Baumg. & Froehl. n. v., *Acanthocladium radiculosum* J. Baumg. & Froehl. n. sp., *Acroporium cataractarum* J. Baumg. & Froehl, n. sp., *Trichosteleum stissophyllum* v. *hydrophilum* J. Baumg. & Froehl. n. v., *Ectropothecium subangense* J. Baumg. & Froehl. n. sp., *Webera denticostata* J. Baumg. & Froehl. n. sp.]

GAMS, H. Beiträge zur Verbreitungsgeschicht und Vergesellschaftung der ozeanischen Archegoniaten in Europa. Veröffentl. Geobot. Inst. Rübe [Zürich] 25: 147-176. 5 *fig.* 1952. [Many species of hepatics]

GIACOMINI, V. Sull'autonomia specifica e sul ciclo di forme di *Campylopus polytrichoides* De Not. Inst. Bot. e Lab. Critt. R. Univ. Pavia Atti 13(1): 45-83. 12 *fig.* 1955. [New: *C. polytrichoides* v. *genuinus* n. v., v. *boraciferus* n. v., v. *boracicola* n. v., ssp. *anacolioides* n. spp., *C. introflexus* v. *brachycarpus* n. v.

GILBERT, W. *Porella pinnata* in Michigan. THE BRYOLOGIST 61(3): 246-247. 1958.

GOSWAMI, S. K. A first record of *Hepaticites* sp. A fossil Bryophyta from the Karewas of Kashmir, India. Current Sci. 26(2): 67. 1957.

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HOFFMAN, ANITA. Untersuchungén über die Geschlechtsdifferenzierung bei haploiden und diploiden Gametophyten von *Bryum capillare* L. Zeitschr. f. Induktive Abstamm. Vererb. 87: 753-768. 17 *fig.* 1956.

HOLMEN, K. Cytotaxonomical studies in some Danish mosses. Bot. Tidsskr. 54(1): 23-43. 51 *fig.* 1958.

IWATSUKI, Z. Two interesting *Fissidens* species common to Japan and eastern North America. Jour. Jap. Bot. 33(8); 245-250. 2 *fig.* 1958. [New: *F. closteri* ssp. *kiushiuensis* (Sak.) Iwats. n. stat.]

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———. *Pohlia rothii* (Correns) Broth. new to Ireland. *Ibid.* 10: 273. 1952.

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Koch, L. F. Review: Musci Japonici Exsiccati, Ser. 12 (Nos. 551-600). Edited by A. Noguchi & S. Hattori, 1957. The Bryologist 61(3) : 261-262. 1958.

Kuc, Marian. Bryological records from the Polish Tatra Mountains. Rev. Bryol. et Lichén. 27(1/2) : 31-37. 3 *fig.* 1958.

Kvet, J. The influence of water-soluble components of peat-moss (*Sphagnum*) on the growth of algae in culture. Preslia 20(3) : 126-137. 3 *tab.* 1958. [Czech with English summary]

Manten, A. A. Palynology of the Miocene Brown-coal mined at Haaurad (Limburg, Netherlands). Acta Bot. Neerl. 7 : 445-488. 17 *fig.* 1958. [Sphagnaceae]

Megaw, W. R. The moss, *Hypnum imponens* Hedw. [Note]. Irish Nat. Jour. 10(2) : 57. 1950.

Mizushima, U. On the identity of 3 mosses (Taxonomic notes on Japanese mosses. I). Jour. Jap. Bot. 33(7) : 214-219. 3 *fig.* 1958.

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Pande, S. K. & N. Chopra. Cytological studies in Indian Mosses. I. Jour. Indian Bot. Soc. 36(3) : 241-247. 13 *fig.* 1957. [*Pogonatum microstomum* (R. Br.) Brid., *P. stevensii* Ren. & Card., *Bryum nitens* Hook. and *Physcomitrium pyriforme* (Hedw.) Brid.]

Persson, H. & W. A. Weber. The bryophyte flora of Mt. McKinley National Park, Alaska. The Bryologist 61(3) : 214-242. 1958. [285 spp.]

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Pilous, Z. Fragmenta bryologica 31-40. Preslia 30(2) : 165-178. 5 *fig.* 1958.

Poelt, J. Systematik der Moose. Fortschr. Bot. (1956) 29 : 70-77. 1 *fig.* 1957.

Polunin, N. The botany of Ice-Island T-3. Jour. Ecol. 46(2) : 323-347. 1 *pl.* 2 *fig.* 1958. [5 hepatics, 13 mosses]

Potier de la Varde, R. Contribution à la flore bryologique africaine (10e article). Rev. Bryol. et Lichén. 27 (1/2) : 1-10. 1958.

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Rasmussen, S. M. Mosfloraen på Falster. Flora og Fauna 64(2/3) : 85-95. 1958.

Roivainen, H. Studien über die Moore Feuerlands. [Faulklands] Ann. Bot. Soc. Zool. Bot. Fennica "Vanamo" 28(2) : 205 pp. 27 *tab.* 45 *fig.* 1954. [mosses, lichens and hepatics]

———. Contribution to the Fuegian species of the genus *Rhacomitrium* Bridel. Arch. Soc. "Vanamo" 9(2) : 85-98. 7 *fig.* 1955. [Keys; new: *R. austrogeorgicum* v. *Kranckii* n. v., *R. geminatum* n. sp., *R. stenocladoides* n. sp., *R. subrupestre* n. sp., *R. substriatipilum* n. sp.]

———. *Bucklandia Bartramii*, a new genus and species of leaf moss from Tierra del Fuego. *Ibid.* 9(2) : 98-100. 2 *fig.* 1955.

Ruttner, F. Zur Ökologie tropischer Wassermoose. Arch. f. Hydrobiol. Suppl. 21(3/4) : 343-381. 3 *tab.* 1955.

Rybníček, K. Neue Lokalitäten von *Trichophorum alpinum*, *Paludella squarrosa* und *Meesea triquetra*. Preslia 30(2) : 203-207. 1 *map.* 1958. [German, Russian, Czech.]

†SAINSBURY, G. O. K. Two new species of Tasmanian mosses. Victorian Nat. [Melbourne] 70(2): 30-31. 1953. [New: *Dicranoloma perichaetiale* n. sp., *Blindia tasmanica* n. sp.]

———. Notes on Tasmanian mosses from Rodway's Herbarium. I. Roy. Soc. Tasmania, Papers, Proc. 87: 83-91. 1953.

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SKOTTSBERG, C. The vegetation of the Juan Fernandez Islands. Nat. Hist. of Juan Fernandez and Easter Islands 2: 793-960. 1953. [Many references to bryophytes]

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STØRMER, P. Some mosses from the phytogeographical excursion 1-9 through the Armorican massive in 1954. Rev. Bryol. et Lichén. 27(1/2): 13-16. 1958.

SUZUKI, H. Varations in *Sphagnum Junghuhnianum* var. *pseudomolle* Warnst. and the status of *Sph. kliense* Warnst. Jap. Jour. Bot. 15(2): 186-198. 6 *fig.* 1956. [New: *S. junghuhnianum* ssp. *pseudomolle* (Warnst.) n. stat.]

TALLIS, J. H. Studies in the biology and ecology of *Rhacomitrium lanuginosum* Brid. I. Distribution and ecology. Jour. Ecology 46(2): 271-288. 2 *fig.* 1958.

TAVARES, C. N. Rev. Pe. Alphonse Luisier, S.J., Dr. h.c. 6.II.1872-4.XI. 1957. Rev. Bryol. et Lichén. 27(1/2): 107-111. 1 *pl.* 1958.

TAYLOR, E. C., SR. Residual leaves from brood-branches of *Philonotis caespitosa*. THE BRYOLOGIST 61(3): 257-259. 7 *fig.* 1958.

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VAARAMA, A. Cytological observations on *Pleurozium schreberi*, with special reference to centromere evolution. Ann. Bot. Soc. "Vanamo" 28(1): 1-59. 65 *fig.* 1954.

VAJDA, L. *Fissidens kosaninii* Latzel dans la Montagne Börzsöny en Hongrie. Rev. Bryol. et Lichén 27(1/2): 49-51. 1958.

WATANABE, R. Notes on Japanese mosses. Jour. Jap. Bot. 33(7): 198. 1958.

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VAN DER WIJK, R. Precursory studies on Malaysian mosses. II. A preliminary key to the moss genera. Blumea 9(1): 143-186. 1958.

WILLIS, J. H. Systematic notes on Victorian Mosses—6. Victorian Nat. 74: 23-25. 1957.

WOLF, F. T. Comparative chlorophyll content of the two generations of bryophytes. Nature 181: 579-580. 1958. [*Anthoceros carolinianus, Polytrichum commune, Dicranum scoparium*]

RECENT LITERATURE ON LICHENS—29[1]

WILLIAM L. CULBERSON[2]

ABBAYES, H. DES. Lichenes. 14 pp. *in* Institut Royal des Sciences Naturelles de Belgique, "Exploration Hydrobiologique du Lac Tanganika (1946-1947)," Vol. 4, Fasc. 4. Bruxelles. 1958. [33 spp.]

———. Résultats des expéditions scientifiques genevoises au Népal en 1952 et 1954 (Partie botanique). 12.—*Cladonia* (Lichens). Candollea 16: 201-209. *Fig.* 22. 1958. [10 spp. New: *C. yunnana* (Vain.) n. c., *C. delavayi* n. sp.]

———. *Cladonia* (Lichens) récoltés par la Mission zoologique suisse aux Indes. *Ibid.* 16: 211-214. 1958. [9 spp.]

ACKER, L., W. DIEMAIR & E. STENHAMMER. Über das Lichenin des Hafers. I. Mitteilung. Eigenschaften, Darstellung und Zusammensetzung des schleimbildenden Polysaccharids. Zeitschr. für Lebensmittel-Untersuch. & -Forsch. 100(3): 180-188. *2 fig.* 5 *tab.* 1955.

———, ———, & ———. Über das Lichenin des Hafers. II. Mitteilung. Molekulargewichtsbestimmung und weitere Untersuchungen zur Konstitution. *Ibid.* 102(4): 225-231. *3 fig.* *2 tab.* 1955.

BÖCHER, T. W. & M. WEIS BENTZON. Density determination in plant communities. Oikos 9(1): 35-56. 3 + *2 fig.* 5 + 4 *tab.* 1958. [32 lichens.]

BORNKAMM, R. Die Bunte-Erdflechter-Gesellschaft im sudwestlichen Harzvorland. Ein Beitrag zur floristichen Soziologie von Kryptogamengesellschaften. Ber. Deutsch. Bot. Gesell. 71(7): 253-270. *3 fig.* 5 *tab.* 1958.

BOULY DE LESDAIN, M. Notes lichénologiques. N° XLIII. Bull. Soc. Bot. France 105(5-6): 230-237. 1958. [New: *Ramalina obtusata* v. *cassidiformis* n. v., *Evernia prunastri* f. *globulosa* n. f., *Caloplaca* (Gasparrinia) *bilewskii* n. sp.]

DUVIGNEAUD, P. Les *Stereocaulon* des hautes montagnes du Kivu. Essai anatomo-systématique. Lejeunea, Mém. n° 14: 1-144. 41 *fig.* (1955) 1956. [Recognition of 13 spp. Keys. New: *Gymnocaulon* n. gen., *G. caespitosum* (Redgr.) n. c., *G. gregarium* (Redgr.) n. c.; *Stereocaulon* sect. Eustereocaulon ser. Granulata n. ser. and ser. Umbilicata n. ser.; *S.* subgen. Rhopalophoron n. subgen. with ser. Protoclavulifera n. ser. and ser. Euclavulifera n. ser.; S. subgen. Lobophoron n. subgen.; *S. microthuja* n. sp., *S. ruwenzoriense* n. sp., *S. nigromaculatum* n. sp., *S. furfuraceum* n. sp., *S. karisimbiense* n. sp., *S. penicillium* n. sp., *S. haumanianum* n. sp., *S. mamillosum* n. sp., *S. pomiferum* n. sp., *S. humbertii* n. sp.]

FERNÁNDEZ, O. & A. PIZARROSO. Contribución a la química de los líquenes. Estudio de la *Usnea canariensis* (D.R.). Rev. de la Real Acad. de Cien. Exactas, Fis. & Nat. de Madrid 52(3): 557-563. 1 *fig.* 1958.

FREY, E. Einige Charakterarten der Flechtenvegetation vom Monseny und den Pyrenäen und Vergleiche mit der Schweiz. Mitt. der Naturforsch. Gesell. in Bern. N.F. [Sitzungsber. der Bernischen Bot. Gesell. aus dem Jahre 1956] 15: xxxiii-xxxvi. *2 fig.* (1956) 1957. [Abstract.]

———. Die anthropogenen Einflüsse auf die Flechtenflora und -vegetation in verschiedenen Gebieten der Schweiz. Ein Beitrag zum Problem der Ausbreitung und Wanderung der Flechten. Veröffentl. des Geobot. Inst.

[1] Names of new taxa from the Americas are marked with an asterisk (*).

[2] Dept. of Botany, Duke University, Durham, N. C.

Rübel in Zürich [Festschr. Werner Lüdi] Heft 33: 91-107. *2 tab.* 1958. [Many spp.]

———. Die Veränderung der Flechtenvegetation in der Versuchsflächen der Schynigeplatte von 1945 bis 1954. Ber. des Geobot. Forschungsinst. Rübel in Zürich 1957: 59-80. *7 tab.* (1957) 1958.

GALLÉ, L. A Szegedi Fehértó zuzmóflórája. [Flora lichenica lacus "Fehértó" Szegediensis.] Móra Ferenc Múz. Évkönyve [Szeged] 1957: 237-250. *2 tab.* 1957. [47 spp. Latin summary.]

GATES, B. N. A new soil-binder for preserving lichen specimens. THE BRYOLOGIST 61(3): 249-252. 1958.

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GROENHART, P. Two new Malaysian lichens. Blumea. Suppl. IV(H. J. Lam Jubilee Vol.): 107-112. *3 fig.* 1958. [New: *Phacographina maxima* n. sp., *Bombyliospora lamii* n. sp.]

HALE, M. E., JR. Chemical components of type specimens in *Parmelia*—I. Brittonia 10(4): 177-180. 1958. [20 spp.]

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HALICZ, B. [&] S. KUZIEL. Materiały do flory porostów Wyżyny Łódskiej. [Contribution aux matières des lichens du haut plateau de Lódz (Pologne).] Zeszyty Nauk. Uniwersytetu Łódzieko, Nauk. Mat.-Przyrodnicze, ser. II. 1958: 101-125. *5 tab.* 1958. [156 spp.]

HESS, D. Über die Papierchromatographie von Flechtenstoffen. Planta 52(1): 65-76. *2 fig. 3 tab.* 1958. [About 90 spp.]

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WIGGINS, I. L. & D. G. MACVICAR, JR. Notes on the plants in the vicinity of Chandler Lake, Alaska. Contrib. Dudley Herb. [Stanford University] 5(3): 69-95. 1 *fig.* 1958. [9 lichens, p. 76.]

NEWS AND NOTES

FATHER G. FOREAU of Sacred Heart College, Shembaganur, Madurai District, South India, is offering for sale a series of specimens of mosses collected in the Palni Hills at elevations of 4000 to 8000 feet. The specimens are generous and well prepared in envelopes bearing handwritten labels from the Sacred Heart College Herbarium. Many of the species represented were described from Father Foreau's collections by Dixon (e.g., 1931, Jour. Bot.) and Potier de la Varde (*e.g.*, 1927, Arch.

de Bot.; 1928, 1930, Ann. Crypt. Exot.) separately and jointly (*e.g.*, 1927, Arch. de Bot.; 1930, Ann. Crypt. Exot.). Material of *Foreauella* (Sematophyllaceae), one of three genera described from Rev. Foreau's collections, combined with specimens of many of the more than 50 species he gathered for the first time highlight the series. Some of the older specimens are duplicates of material determined by Dixon and Potier de la Varde while duplicates of more recently gathered material have been determined at Kew. Although offered for sale in "Series" of 50 specimens at $5.50 per series, there is occasional substitution of species (two in 100 specimens examined) from those given in the two series lists which are available on request. Apparently supplies of all species are not equally abundant. Even so, the unique character of the moss flora of the region assures bryologists of interesting and unusual additions to their herbaria. Should workers be interested in only certain species, arrangements can be made to purchase specimens individually. Proceeds from the sale of specimens assist in the support of botany at the college.—H. A. MILLER.

The author of the article on "Freehand sectioning of moss leaves and stems" (THE BRYOLOGIST 60: 17. 1957) has had numerous requests for a specific compound which can be ordered as the quartenary amine disinfectant referred to. A suitable substance is Isothan Q-15, manufactured by Onyx Oil and Chemical Co., Warren & Morris Streets, Jersey City 2, N. J. This should be prepared as a stock solution in distilled water, diluted 1:1000, the stock solution being used in the making of formulae as if it were pure water. In this way it can be used to prevent fungus attack in 10% glycerine, in glycerin jelly (replacing phenol), and in spraying mosses which have to be brought to maturity indoors.

DR. WINONA H. WELCH will present a course in mosses and liverworts at the summer session of Indiana University, June 10-August 7. The course (Botany B343) carries three hours credit.

HARVEY ALFRED MILLER has been given NSF support for a 3-year program of study of hepatics of the Pacific islands, including field work in Micronesia during the summer of 1960. The Pacific Science Board is helping with arrangements for travel to Guam, Palau, Truk, and Ponape. Other islands will be visited if transportation is available.

Several bryologists have expressed disagreement with the present starting date for nomenclature of the Musci, Dec. 31, 1801, which excludes all names proposed in 1801 except those in Hedwig's *Species Muscorum*. In the January issue of *Taxon*, it was announced that a change will be made, either to Jan. 1, 1801 or April 19, 1801 (the latter being the actual date of Hedwig's *Species Muscorum*). The decision will be made at the Montreal Congress.

The University of Michigan Biological Station again is offering field courses and research in bryology and lichenology under the direction of Professor A. J. SHARP of the University of Tennessee, at its permanent camp on Douglas Lake in northern Michigan. In addition, 15 other courses and research covering most aspects of field and freshwater biology will be conducted by the faculty of 15 other prominent biologists from seven other colleges and universities.

Through the generosity of the National Science Foundation, approximately 30 awards are available to undergraduate and graduate stu-

dents and independent investigators in any aspect of biology appropriate to the Station.

For full information, address Biological Station, The University of Michigan, Ann Arbor, Michigan.

LEWIS ANDERSON has also received an NSF grant for the preparation of a manual of eastern American mosses, in collaboration with Howard Crum.

The annual Spring Wildflower Pilgrimage in the Great Smoky Mountains National Park, April 23-25, 1959, will again feature a moss and fern walk. Information is available from the Gatlinburg Chamber of Commerce, Dept. W. P., Box 208, Gatlinburg, Tennessee.

DR. MATTI AL AISH of the University of Baghdad is spending the winter with Lewis Anderson at Duke University, studying the cytology of mosses. Also studying the cytology of bryophytes is DR. R. S. CHOPRA of East Punjab University; he is at the University of Tennessee this winter. He and A. J. Sharp also plan to work on the correlations of Indian and American bryology.

Dr. and Mrs. HENRY S. CONARD will be at Highlands Biological Station, North Carolina, July 6 to Aug. 15, participating in a seminar on the teaching of biology and caring for a few students of bryology.

Parts 1-3 of Müller's *Die Lebermoose Europas*, 3 Auflage, went out of print before all the remaining parts were issued. Reprints are available for 67.80 DM ($17.00 American) from H. R. Englemann (J. Cramer), P. O. Box 166, Weinheim/Bergstr., Germany.

A 4-credit course in bryophytes will be presented at the Lake Itasca Forestry and Biological Station in northwestern Minnesota, June 19-July 18, by JANET STEIN. For information, write Dean of the Summer Session, 960 Johnston Hall, University of Minnesota, Minneapolis 14.

RUDOLF M. SCHUSTER has received a 4-year NSF grant for a generic revision of the Ptilidiinae, based as much as possible on axial and sporophyte anatomy and the form of oil bodies. He plans to spend some months in New Zealand and possibly 3-4 months in southern South America.

Dr. Schuster plans to spend two weeks in June collecting on Cape Breton Island, Nova Scotia.

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THE HEPATIC EXCHANGE

Beginning January 1, 1939, this Exchange has been operated under the same rules as The Moss Exchange. Privileges are available only to members of the American Bryological Society who have paid annual dues of 25c to DR. LEO F. KOCH, Herbarium, 350 Natural Science Bldg., University of Illinois, Urbana, Ill. Only fully determined specimens in packets with complete data will be accepted. It is suggested that there be at least five packets of each species with an extra which will be forwarded to the Curator of Hepatics for the American Bryological Society Hepatic Herbarium. All material for determination should be sent to the Curator of Hepatics, DR. MARGARET FULFORD, Department of Botany, University of Cincinnati, Cincinnati, Ohio.

THE MOSS EXCHANGE

As announced in THE BRYOLOGIST **38**: 100, Sept.-Oct., 1935, there is now an exchange for mosses. This exchange is available to members of the American Bryological Society upon payment of annual dues of 25c to DR. E. H. KETCHLEDGE, Dept of Forest Botany, State College of Forestry, Syracuse 10, New York. Only fully identified specimens in packets with complete data on them should be sent in. It is suggested that there be five or more packets of each species.

These two exchanges offer an excellent opportunity for A.B.S. members to build up their own herbaria of choice, well-labelled specimens.